lake winnipeg, churchill & nelson rivers study board CANADA MANITOBA 1971-75

# technical report

CANADA - MANITOBA
LAKE WINNIPEG, CHURCHILL and
NELSON RIVERS STUDY BOARD
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The Honourable Jeanne Sauvé,
Minister of the Environment,
OTTAWA, Ontario.

The Honourable Sidney Green, Q.C.,
Minister of Mines, Resources and Environmental Management,
WINNIPEG, Manitoba.

Madame and Sir:

The Lake Winnipeg, Churchill and Nelson Rivers Study Board has completed its investigations in accordance with the terms of the Agreement between the governments of Canada and Manitoba dated August, 1971, and is pleased to submit its Technical Report which includes eight appendices.

Respectfully submitted,

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# acknowledgements

The working documents which were prepared for the Lake Winnipeg, Churchill and Nelson Rivers Study Board and the Board's Summary and Technical reports are the results of the efforts of many individuals and agencies. While those who were awarded contracts by the Board for specific investigations were reimbursed according to the terms of their contracts, much valuable advice and information was provided at no charge. In addition, many agencies and individuals participated in and contributed to the Study that did not have contracts with the Board.

It is difficult, if not impossible, to record an acknowledgement of all the work undertaken during the course of the Study by each individual and agency. Therefore, while inadequate, the Study Board wishes to express its appreciation to all the individuals and agencies who contributed to the Study.

# preface

The Nelson River and the Churchill River in northern Manitoba are two of Canada's largest rivers. The Nelson River drains an area of 414,000 square miles extending from the foothills of the Rocky Mountains to within twelve miles of Lake Superior. The Churchill River drainage basin covers an area of about 115,000 square miles from Beaver Lake, northeast of Edmonton to Hudson Bay. The drainage area of these two great river systems covers an area approximately twice the size of the Province of Manitoba. Over the past decade, use of the waters of that portion of the Churchill River and Nelson River drainage basins located in Manitoba has been accelerating. The main use to date has been in the development of hydroelectric power by the provincially owned public utility, Manitoba Hydro, under authorization by the provincial government. The people and industries of Manitoba are utilizing more and more electrical energy every year. Demand is expected to double during the next decade. Along with this increasing demand for electrical energy, there is an ever increasing awareness of the need to preserve Manitoba's natural environment, and to allocate natural resources with a view to benefiting Manitobans now and in the future.

Following the decision by the government of Manitoba to authorize the Nelson River hydroelectric development program, attention focused upon the major changes that could be expected to affect all direct and indirect users of these waters. Consequently, in August, 1971, the federal and provincial governments entered into an Agreement to undertake a comprehensive study of the effects of the regulation of Lake Winnipeg, diversion from the Churchill River and development of the hydroelectric potential of the Diversion Route. This report presents the findings, conclusions and recommendations of the study. The economic and technical feasibility of the program to develop the hydroelectric potential of the Nelson River was not examined. The decisions to undertake the development, and to proceed with the regulation of Lake Winnipeg and the diversion from the Churchill River were made prior to the initiation of this study. The study was limited to examination of conditions that existed prior to the commencement of the development program, to prediction of effects of this program, and to recommendation of measures that might be undertaken to enhance the overall benefits and to mitigate undesirable effects of the hydroelectric development.

A Board, composed of six members representing the federal and provincial governments, was responsible for conducting the study. The Board exercised this function by appointing a Study Director to administer the study program and by appointing a Technical Advisory Committee of two members representing each government, to assist the Director.

All working documents, on which the report is based, are reproduced as appendices.

While this report deals specifically with the task assigned to the Study Board under the terms of the intergovernmental Agreement, it can serve as a reference for future northern development programs and monitoring studies.

# table of contents

## CHAPTER 1 - FINDINGS AND RECOMMENDATIONS

NORTHERN COMMUNITIES .......... 1-1
  DEMOGRAPHIC RESOURCE BASE .......... 1-3
  ECONOMIC SUBDIVISIONS .......... 1-5
  COMMUNITY ANALYSES .......... 1-7

IMPLICATIONS FOR NORTHERN MANITOBA .......... 1-7

IMPACT STAGES .......... 1-8
  TANGIBLE IMPACTS .......... 1-9
    EMPLOYMENT .......... 1-9
    TRANSPORTATION .......... 1-11
    NATURAL RESOURCE UTILIZATION .......... 1-12
      Commercial Fishery .......... 1-12
      Wild Fur Industry .......... 1-13
      Mining - Forestry .......... 1-13
  INTANGIBLE IMPACTS .......... 1-14
    SOCIAL STRESS .......... 1-14
    NUTRITION .......... 1-14
    CULTURAL CHANGE .......... 1-14

RECOMMENDATIONS .......... 1-15
  LAKE WINNIPEG .......... 1-19
  OUTLET LAKES .......... 1-19
  SOUTHERN INDIAN LAKE .......... 1-20
  DIVERSION ROUTE .......... 1-20
  LOWER CHURCHILL RIVER .......... 1-21

FOOTNOTES .......... 1-23

## CHAPTER 2 - INTRODUCTION AND BACKGROUND

INTRODUCTION.......... 2-1

MANITOBA HYDRO'S ROLE.......... 2-2

HISTORY OF NELSON RIVER HYDROELECTRIC DEVELOPMENT PROGRAM.......... 2-3

FOOTNOTES.......... 2-8

## CHAPTER 3 - LAKE WINNIPEG,,CHURCHILL AND NELSON RIVERS STUDY

INTRODUCTION.......... 3-1

OBJECTIVE.......... 3-2

ORGANIZATIONAL FRAMEWORK.......... 3-2

FINANCIAL ARRANGEMENTS.......... 3-3

LIMITATIONS OF THE STUDY.......... 3-3

STUDY GUIDELINES.......... 3-4

CONDUCTING THE STUDY.......... 3-5

STUDY AREAS.......... 3-6
  AREA 1 - LAKE WINNIPEG.......... 3-6
  AREA 2 - OUTLET LAKES.......... 3-8
  AREA 3 - DIVERSION ROUTE (RAT-BURNTWOOD RIVERS).......... 3-8
  AREA 4 - SOUTHERN INDIAN LAKE.......... 3-9
  AREA 5 - LOWER CHURCHILL RIVER.......... 3-9
  AREA 6 - LOWER NELSON RIVER.......... 3-9

STUDY PROGRAM.......... 3-10

REPORTING RESULTS.......... 3-11
  SPECIAL ISSUES.......... 3-11

## CHAPTER 4 - LAKE WINNIPEG REGULATION AND CHURCHILL RIVER DIVERSION PROJECTS

INTRODUCTION.......... 4-1

LAKE WINNIPEG REGULATION.......... 4-2
    2-MILE CHANNEL.......... 4-2
    8-MILE CHANNEL.......... 4-2
    OMINAWIN BYPASS CHANNEL.......... 4-3
    KISIPACHEWUK RAPIDS.......... 4-4

JENPEG CONTROL STRUCTURE .......... 4-4
KISKITTO LAKE .......... 4-5
EAST CHANNEL CONTROL STRUCTURE .......... 4-6

CHURCHILL RIVER DIVERSION .......... 4-7
MISSI FALLS .......... 4-7
SOUTH BAY - ISSETT LAKE DIVERSION CHANNEL .......... 4-7
NOTIGI CONTROL STRUCTURE .......... 4-9
WUSKWATIM, MANASAN FALLS AND FIRST RAPIDS .......... 4-10

## CHAPTER 5 - AREA 1 - LAKE WINNIPEG

GEOGRAPHY .......... 5-1
LOCATION .......... 5-1
CLIMATE .......... 5-1
PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL .......... 5-2
VEGETATION .......... 5-2
DRAINAGE PATTERN .......... 5-3
HUMAN HABITATION .......... 5-3

EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE PHYSICAL ENVIRONMENT .......... 5-6
WATER REGIME CHANGES .......... 5-6
CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER .......... 5-10
PHYSICAL CHANGES TO THE LAKESHORE .......... 5-10
MARSHES .......... 5-11
EFFECT ON MARSHES .......... 5-12
SHORELINES .......... 5-12
Shoreline Erosion .......... 5-12
Sand Transport .......... 5-13
EFFECT ON SHORELINES .......... 5-15
Effect on Shoreline Erosion .......... 5-15
Effect on Sand Beaches .......... 5-15

EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION .......... 5-17
LIMNOLOGY AND FISHERIES .......... 5-17
LIMNOLOGY .......... 5-17
EFFECT ON LIMNOLOGY .......... 5-17
FISHERIES .......... 5-17
Commercial Fishing .......... 5-18
Sport Fishing .......... 5-18
Domestic Fishing .......... 5-19
Mink Ranch Fishing .......... 5-19
Value to Fishery .......... 5-19
EFFECT ON FISHERIES .......... 5-19
WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE .......... 5-20
WILDLIFE HABITAT AND POPULATIONS .......... 5-20
Furbearers .......... 5-20
Waterfowl .......... 5-21

      - Colonial Nesting Birds .......... 5-23
    - EFFECT ON WILDLIFE HABITAT AND POPULATIONS .......... 5-24
      - Effect on Furbearers .......... 5-24
      - Effect on Waterfowl .......... 5-24
      - Effect on Colonial Nesting Birds .......... 5-25
    - WILDLIFE USE .......... 5-25
      - Waterfowl Hunting .......... 5-25
      - Trapping .......... 5-26
    - EFFECT ON WILDLIFE USE .......... 5-26
      - Effect on Waterfowl Hunting .......... 5-26
      - Effect on Trapping .......... 5-27
  - FOREST RESOURCES AND FORESTRY .......... 5-27
    - FOREST RESOURCES .......... 5-27
    - EFFECT ON FOREST RESOURCES .......... 5-27
    - FORESTRY .......... 5-27
    - EFFECT ON FORESTRY .......... 5-27
  - MINERAL RESOURCES AND MINING .......... 5-28
    - MINERAL RESOURCES .......... 5-28
    - MINING .......... 5-28
  - OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION .......... 5-29
    - USE OF OUTDOOR RECREATION RESOURCES .......... 5-29
    - EFFECT ON OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION .......... 5-31
  - TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES .......... 5-33
    - TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES .......... 5-33
    - EFFECT ON TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES .......... 5-34

- EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON COMMUNITIES ON LAKE WINNIPEG .......... 5-39
  - COMMUNITY INFRASTRUCTURE .......... 5-39
    - DYKES AROUND THE SOUTH BASIN .......... 5-39
    - EFFECT ON DYKES AROUND THE SOUTH BASIN .......... 5-41
    - OTHER STRUCTURES ON THE SOUTH BASIN .......... 5-42
    - EFFECT ON OTHER STRUCTURES ON THE SOUTH BASIN .......... 5-44

- SUGGESTED MEASURES FOR THE LAKE WINNIPEG AREA TO ENHANCE THE BENEFITS OF THE LAKE WINNIPEG REGULATION PROJECT .......... 5-45

- FOOTNOTES .......... 5-46

## CHAPTER 6 - AREA 2 - OUTLET LAKES

- GEOGRAPHY .......... 6-1
  - LOCATION .......... 6-1
  - CLIMATE .......... 6-1
  - PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL .......... 6-3
  - VEGETATION .......... 6-3
  - DRAINAGE PATTERNS .......... 6-4
  - HUMAN HABITATION .......... 6-5

- EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE PHYSICAL ENVIRONMENT .......... 6-8
  - WATER REGIME CHANGES .......... 6-8

EAST AND WEST CHANNELS.............................. 6-8
KISKITTOGISU AND PLAYGREEN LAKES.............................. 6-9
KISKITTO LAKE.............................. 6-12
CROSS LAKE.............................. 6-14
SPECIAL OPERATING CONDITIONS AT JENPEG.............................. 6-15
ICE REGIME CHANGES.............................. 6-15
CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER.............................. 6-16
PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS.............................. 6-19
PLAYGREEN LAKE.............................. 6-19
KISKITTOGISU LAKE.............................. 6-21
KISKITTO LAKE.............................. 6-22
CROSS LAKE.............................. 6-22
WEST CHANNEL.............................. 6-24
EAST CHANNEL.............................. 6-24
8-MILE CHANNEL.............................. 6-25
2-MILE CHANNEL.............................. 6-26

EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION.............................. 6-28
LIMNOLOGY AND FISHERIES.............................. 6-28
LIMNOLOGY.............................. 6-28
EFFECT ON LIMNOLOGY.............................. 6-30
Effect of the 2-Mile Channel.............................. 6-30
Effect of the 8-Mile Channel.............................. 6-32
Effect of the Ominawin Bypass Channel.............................. 6-33
Effect of Jenpeg.............................. 6-33
Effect on Cross Lake.............................. 6-35
Effect on Kiskitto Lake.............................. 6-35
FISHERIES.............................. 6-36
Commercial Fishery.............................. 6-36
Domestic Fishery.............................. 6-39
Sport Fishery.............................. 6-40
EFFECT ON FISHERIES.............................. 6-40
Effect of the 2-Mile Channel.............................. 6-40
Effect of the 8-Mile Channel.............................. 6-41
Effect of the Ominawin Bypass Channel.............................. 6-41
Effect of the Jenpeg Forebay and Tailrace.............................. 6-41
Effect of the All-Weather Road to Jenpeg.............................. 6-42
Effect of Reduced Mobility on Cross Lake.............................. 6-42
Effect on Fish Exploitation.............................. 6-43
WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE.............................. 6-44
WILDLIFE HABITAT AND POPULATIONS.............................. 6-45
Ungulates.............................. 6-45
Furbearers.............................. 6-47
Birds.............................. 6-48
EFFECT ON WILDLIFE HABITAT AND POPULATIONS.............................. 6-49
Effect on Ungulates.............................. 6-49
Effect on Furbearers.............................. 6-51
Effect on Birds.............................. 6-51
WILDLIFE USE.............................. 6-52
Hunting.............................. 6-52
Trapping.............................. 6-54

- EFFECT ON WILDLIFE USE 6-56
  - Effect on Hunting 6-56
  - Effect on Trapping 6-57
- FOREST RESOURCES AND FORESTRY 6-57
  - FOREST RESOURCES 6-58
  - EFFECT ON FOREST RESOURCES 6-58
    - Effect of Jenpeg 6-58
    - Effect on Kiskittogisu Lake 6-59
    - Effect of the 2-Mile, 8-Mile and Ominawin Bypass Channels 6-59

FORESTRY

- Forest Management Unit 82 6-60
- Forest Management Unit 83 6-60
- EFFECT ON FORESTRY 6-60
  - Effect on Forest Management Unit 82 6-61
  - Effect on Forest Management Unit 83 6-62
- MINERAL RESOURCES AND MINING 6-64
  - MINERAL RESOURCES 6-64
  - EFFECT ON MINERAL RESOURCES 6-65
  - MINING 6-65
  - EFFECT ON MINING 6-65
- OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION 6-67
  - OUTDOOR RECREATION RESOURCES 6-68
    - Recreation Potential Without the Regulation Project 6-68
    - Recreation Potential With the Regulation Project 6-69
  - EFFECT ON OUTDOOR RECREATION RESOURCES 6-70
  - USE OF OUTDOOR RECREATION RESOURCES 6-73
  - EFFECT ON THE USE OF OUTDOOR RECREATION RESOURCES 6-73
- ARCHAEOLOGICAL RESOURCES 6-73
  - ARCHAEOLOGICAL RESOURCES 6-74
  - EFFECT ON ARCHAEOLOGICAL RESOURCES 6-78
- TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES 6-78
  - TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES 6-79
  - EFFECT ON TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES 6-81
  - EFFECT ON TRANSPORTATION SERVICES TO NORWAY HOUSE AND CROSS LAKE COMMUNITIES 6-84
  - EFFECT ON WINTER TRANSPORTATION 6-87
    - Effect on the 2-Mile Channel 6-88
    - Effect on the 8-Mile Channel 6-88
    - Effect in the Norway House Area 6-88
    - Effect in the Cross Lake Area 6-89

EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON COMMUNITIES 6-90
- CROSS LAKE 6-90
  - THE ECONOMY 6-93
  - EFFECT ON THE ECONOMY 6-93
    - Effect on Fisheries 6-93
    - Effect on Trapping 6-94
    - Effect on Hunting 6-96
    - Effect on Local Forestry Activities 6-96
    - Effect on Construction Activities 6-96
  - THE LABOUR FORCE 6-97
  - EFFECT ON THE LABOUR FORCE 6-99
  - GOVERNMENT TRANSFER PAYMENTS 6-100
  - EFFECT ON GOVERNMENT TRANSFER PAYMENTS 6-100

    COMMUNITY INFRASTRUCTURE .......... 6-10
    EFFECT ON COMMUNITY INFRASTRUCTURE .......... 6-1
    SOCIAL SYSTEM .......... 6-1
    EFFECT ON THE SOCIAL SYSTEM .......... 6-10
  NORWAY HOUSE .......... 6-10
    THE ECONOMY .......... 6-10
    EFFECT ON THE ECONOMY .......... 6-10
    THE LABOUR FORCE .......... 6-10
    EFFECT ON THE LABOUR FORCE .......... 6-10
    EFFECT ON COMMUNITY INFRASTRUCTURE .......... 6-108

SUGGESTED MEASURES FOR THE OUTLET LAKES AREA
TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS
OF THE LAKE WINNIPEG REGULATION PROJECT .......... 6-110

FOOTNOTES .......... 6-112

## CHAPTER 7 - AREA 3 - DIVERSION ROUTE

GEOGRAPHY .......... 7-1
  LOCATION .......... 7-1
  CLIMATE .......... 7-2
  PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL .......... 7-2
  VEGETATION .......... 7-3
  DRAINAGE PATTERNS .......... 7-3
  HUMAN HABITATION .......... 7-5

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER
ON THE PHYSICAL ENVIRONMENT .......... 7-7
  WATER REGIME CHANGES .......... 7-7
  ICE REGIME CHANGES .......... 7-9
  CHANGES IN THE CHEMICAL, BACTERIOLOGICAL
  AND PHYSICAL PROPERTIES OF WATER .......... 7-9
  PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS .......... 7-11
    ABOVE NOTIGI .......... 7-11
    BELOW NOTIGI .......... 7-12

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER
ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION .......... 7-14
  LIMNOLOGY AND FISHERIES .......... 7-14
    LIMNOLOGY .......... 7-14
    EFFECT ON LIMNOLOGY .......... 7-15
    FISHERIES .......... 7-16
      Commercial Fishery .......... 7-16
      Domestic Fishery .......... 7-17
      Sport Fishing .......... 7-17
    EFFECT ON FISHERIES .......... 7-18
      Effect on Commercial Fishery .......... 7-18
      Effect on Sport Fishery .......... 7-18

WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE.................. 7-18
  WILDLIFE HABITAT AND POPULATIONS................................ 7-18
    Ungulates.................................................... 7-18
    Furbearers................................................... 7-19
    Waterfowl.................................................... 7-20
  EFFECT ON WILDLIFE HABITAT AND POPULATIONS...................... 7-21
    Effect on Ungulates.......................................... 7-22
    Effect on Furbearers......................................... 7-22
    Effect on Waterfowl.......................................... 7-24
  WILDLIFE USE.................................................... 7-24
    Hunting...................................................... 7-24
    Trapping..................................................... 7-26
  EFFECT ON WILDLIFE USE.......................................... 7-27
    Effect on Hunting............................................ 7-27
    Effect on Trapping........................................... 7-28
FOREST RESOURCES AND FORESTRY..................................... 7-30
  FOREST RESOURCES................................................ 7-30
  EFFECT ON FOREST RESOURCES...................................... 7-30
    Effect Above Notigi.......................................... 7-30
    Effect Below Notigi.......................................... 7-31
    Effect of the Proposed Wuskwatim Generating Station........... 7-31
    Effect of the Proposed Manasan Generating Station............. 7-31
  FORESTRY........................................................ 7-32
  EFFECT ON FORESTRY.............................................. 7-32
MINERAL RESOURCES AND MINING...................................... 7-33
  MINERAL RESOURCES............................................... 7-33
  EFFECT ON MINERAL RESOURCES..................................... 7-33
  MINING ACTIVITY................................................. 7-34
  EFFECT ON MINING ACTIVITY....................................... 7-34
OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION................. 7-34
  OUTDOOR RECREATION RESOURCES.................................... 7-34
  EFFECT ON OUTDOOR RECREATION RESOURCES.......................... 7-35
  USE OF OUTDOOR RECREATION RESOURCES............................. 7-37
  EFFECT ON THE USE OF OUTDOOR RECREATION RESOURCES............... 7-39
ARCHAEOLOGICAL RESOURCES.......................................... 7-39
  ARCHAEOLOGICAL RESOURCES........................................ 7-39
  EFFECT ON ARCHAEOLOGICAL RESOURCES.............................. 7-42
TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES.............. 7-42
  EXISTING AND PROPOSED TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES........................ 7-43
  EFFECT ON EXISTING AND PROPOSED TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES.............. 7-45

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON COMMUNITIES........................................ 7-48
  NELSON HOUSE.................................................... 7-48
    THE ECONOMY.................................................. 7-48
    EFFECT ON THE ECONOMY........................................ 7-49
      Effect on Trapping......................................... 7-49
      Effect on Fisheries........................................ 7-52
      Effect on Hunting.......................................... 7-53
      Effect on Local Forestry Activity.......................... 7-53
      Effect on Earned Income in the Form of Wages and Salaries..... 7-54

LABOUR FORCE.......... 7-56
EFFECT ON THE LABOUR FORCE.......... 7-58
GOVERNMENT TRANSFER PAYMENTS.......... 7-58
EFFECT ON GOVERNMENT TRANSFER PAYMENTS.......... 7-58
COMMUNITY INFRASTRUCTURE.......... 7-59
EFFECT ON COMMUNITY INFRASTRUCTURE.......... 7-60
SOCIAL SYSTEM.......... 7-61
EFFECT ON THE SOCIAL SYSTEM.......... 7-63
THOMPSON.......... 7-64
EFFECT ON COMMUNITY INFRASTRUCTURE.......... 7-64

SUGGESTED MEASURES FOR THE DIVERSION ROUTE AREA TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE CHURCHILL RIVER DIVERSION PROJECT.......... 7-66

FOOTNOTES.......... 7-68

## CHAPTER 8 - AREA 4 - SOUTHERN INDIAN LAKE

GEOGRAPHY.......... 8-1
LOCATION.......... 8-1
CLIMATE.......... 8-1
PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL.......... 8-2
VEGETATION.......... 8-3
DRAINAGE PATTERNS.......... 8-4
HUMAN HABITATION.......... 8-4

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE PHYSICAL ENVIRONMENT.......... 8-6
WATER REGIME CHANGES.......... 8-6
ICE REGIME CHANGES.......... 8-9
CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER.......... 8-9
PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS.......... 8-9
Moss Lake, Hammond Point, Waddie River (Reach 1).......... 8-11
Missi Falls (Reach 2).......... 8-13
Long Point (Reach 3).......... 8-13
Mulcahy Lake (Reach 4).......... 8-14
Lemay Island (Reach 5).......... 8-14
The Community (Reach 6).......... 8-14
South Bay (Reach 7).......... 8-15
Opachuanau Lake (Reach 8).......... 8-15
Leaf Rapids (Reach 9).......... 8-15

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION.......... 8-16
LIMNOLOGY AND FISHERIES.......... 8-16
LIMNOLOGY.......... 8-16
EFFECT ON LIMNOLOGY.......... 8-19
FISHERIES.......... 8-23
Commercial Fishery.......... 8-23

Winter Fishery.......................................... 8-25
Summer Fishery.......................................... 8-28
Production Potential.................................... 8-28
Domestic Fishery........................................ 8-31
Sport Fishery........................................... 8-31
EFFECT ON FISHERIES..................................... 8-31
Effect on Commercial Fishery............................ 8-32
Effect on Reduced Mobility on Fish Exploitation......... 8-33
Effect on Sport Fishery................................. 8-33
WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE....... 8-34
WILDLIFE HABITAT AND POPULATIONS........................ 8-34
Ungulates............................................... 8-34
Furbearers.............................................. 8-36
Birds................................................... 8-36
EFFECT ON WILDLIFE HABITAT AND POPULATIONS.............. 8-38
Effect on Ungulates..................................... 8-38
Effect on Furbearers.................................... 8-39
Effect on Birds......................................... 8-39
WILDLIFE USE............................................ 8-41
Hunting................................................. 8-41
Trapping................................................ 8-41
EFFECT ON WILDLIFE USE.................................. 8-43
Effect on Hunting....................................... 8-43
Effect on Trapping...................................... 8-44
FOREST RESOURCES AND FORESTRY........................... 8-44
FOREST RESOURCES........................................ 8-44
EFFECT ON FOREST RESOURCES.............................. 8-46
Effect on Manitoba Forestry Resources Specified Area.... 8-46
Effect on the Proposed Permanent Forest Zone............ 8-48
FORESTRY................................................ 8-48
EFFECT ON FORESTRY...................................... 8-49
Effect on the Specified Area............................ 8-50
Effect on Forest Management Units 71, 72 and 73......... 8-50
Effect on Forest Management Unit 75..................... 8-51
OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION...... 8-51
OUTDOOR RECREATION RESOURCES............................ 8-51
Recreation Potential Without Diversion.................. 8-51
Recreation Potential With Diversion..................... 8-52
EFFECT ON OUTDOOR RECREATION RESOURCES.................. 8-53
USE OF OUTDOOR RECREATION RESOURCES..................... 8-54
EFFECT ON THE USE OF OUTDOOR RECREATION RESOURCES....... 8-54
TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES... 8-55
TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES... 8-55
EFFECT ON TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES.. 8-57
EFFECT ON EXISTING AND POTENTIAL RESOURCE PRODUCTS TRAFFIC....... 8-59
EFFECT ON TRANSPORTATION SERVICES TO SOUTH INDIAN LAKE AND LEAF RAPIDS COMMUNITIES........ 8-60

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON COMMUNITIES........ 8-62
SOUTH INDIAN LAKE....................................... 8-62
THE ECONOMY............................................ 8-62
EFFECT ON THE ECONOMY................................... 8-65

Effect on Fisheries........................................ 8-65
Effect on Trapping........................................ 8-65
Effect on Hunting........................................ 8-68
Effect on Local Forestry Activities........................................ 8-68
Effect on Construction Activities........................................ 8-68
Effect on Service Industries........................................ 8-68
THE LABOUR FORCE........................................ 8-69
EFFECT ON THE LABOUR FORCE........................................ 8-69
GOVERNMENT TRANSFER PAYMENTS........................................ 8-70
EFFECT ON GOVERNMENT TRANSFER PAYMENTS........................................ 8-70
COMMUNITY INFRASTRUCTURE........................................ 8-71
EFFECT ON COMMUNITY INFRASTRUCTURE........................................ 8-71
OTHER STRUCTURES ALONG SOUTHERN INDIAN LAKE........................................ 8-73
EFFECT ON OTHER STRUCTURES ALONG SOUTHERN INDIAN LAKE........................................ 8-73
SOCIAL SYSTEM........................................ 8-74
EFFECT ON THE SOCIAL SYSTEM........................................ 8-74
LEAF RAPIDS AND RUTTAN LAKE........................................ 8-76

SUGGESTED MEASURES FOR THE SOUTHERN INDIAN LAKE AREA TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE CHURCHILL RIVER DIVERSION PROJECT........................................ 8-77

FOOTNOTES........................................ 8-79

## CHAPTER 9 - AREA 5 - LOWER CHURCHILL RIVER

GEOGRAPHY........................................ 9-1
LOCATION........................................ 9-1
CLIMATE........................................ 9-1
PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL........................................ 9-2
VEGETATION........................................ 9-3
DRAINAGE PATTERNS........................................ 9-3
HUMAN HABITATION........................................ 9-5

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE PHYSICAL ENVIRONMENT........................................ 9-6
WATER REGIME CHANGES........................................ 9-6
ICE REGIME CHANGES........................................ 9-10
CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER........................................ 9-12
PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS........................................ 9-13
Partridge Breast Lake (Reach 1)........................................ 9-13
Northern Indian Lake (Reach 2)........................................ 9-15
Fidler Lake (Reach 3)........................................ 9-15
Fidler Falls (Reach 4)........................................ 9-16
Billard Lake (Reach 5)........................................ 9-16
Billard Rapids (Reach 6)........................................ 9-17
Upper Canyon (Reach 7)........................................ 9-17
Lower Canyon (Reach 8)........................................ 9-18
Long Island (Reach 9)........................................ 9-18
Long Island to Hudson Bay (Reach 10)........................................ 9-18

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION........................ 9-20
LIMNOLOGY AND FISHERIES................................................ 9-20
LIMNOLOGY.............................................................. 9-20
EFFECT ON LIMNOLOGY.................................................... 9-21
FISHERIES.............................................................. 9-23
EFFECT ON FISHERY...................................................... 9-23
WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE..................... 9-24
WILDLIFE HABITAT AND POPULATIONS....................................... 9-25
Ungulates.............................................................. 9-25
Furbearers............................................................. 9-25
Polar Bears............................................................ 9-28
Waterfowl.............................................................. 9-28
EFFECT ON WILDLIFE HABITAT AND POPULATIONS............................ 9-29
Effect on Ungulates.................................................... 9-29
Effect on Furbearers................................................... 9-29
Effect on Polar Bears.................................................. 9-29
Effect on Waterfowl.................................................... 9-29
WILDLIFE USE........................................................... 9-30
Hunting................................................................ 9-30
Trapping............................................................... 9-31
EFFECT ON WILDLIFE USE................................................. 9-32
Effect on Hunting...................................................... 9-32
Effect on Trapping..................................................... 9-32
OUTDOOR RECREATION..................................................... 9-32
PRESENT RECREATION USE................................................. 9-32
POTENTIAL RECREATION USE............................................... 9-34
EFFECT ON EXISTING AND POTENTIAL RECREATION USE........................ 9-34
TRANSPORTATION AND NAVIGATION.......................................... 9-35
EFFECT ON EXISTING TRANSPORTATION AND NAVIGATION FACILITIES............ 9-35
EFFECT ON RESOURCES AND TRANSPORTATION IMPLICATIONS..................... 9-36
EFFECT ON TRANSPORTATION INFRASTRUCTURE AT CHURCHILL.................... 9-37
PORT OF CHURCHILL - PRESENT AND FUTURE USE............................. 9-37
EFFECT ON PRESENT AND FUTURE USE OF PORT OF CHURCHILL.................. 9-38

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON COMMUNITIES IN THE LOWER CHURCHILL RIVER AREA........................ 9-42
CHURCHILL.............................................................. 9-42
RECREATION............................................................. 9-42
WATER SUPPLY........................................................... 9-42
WASTE DISPOSAL......................................................... 9-45
ILFORD................................................................. 9-45

SUGGESTED MEASURES TO MITIGATE DETRIMENTAL EFFECTS AND TO ENHANCE BENEFITS IN THE LOWER CHURCHILL RIVER AREA OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER........................ 9-46
ICE REGIME............................................................. 9-46
FISHERIES.............................................................. 9-46
WILDLIFE............................................................... 9-48
RECREATION............................................................. 9-48
CHURCHILL WATER SUPPLY................................................. 9-49
ILFORD................................................................. 9-49

FOOTNOTES.............................................................. 9-50

# CHAPTER 10 - AREA 6 - LOWER NELSON RIVER

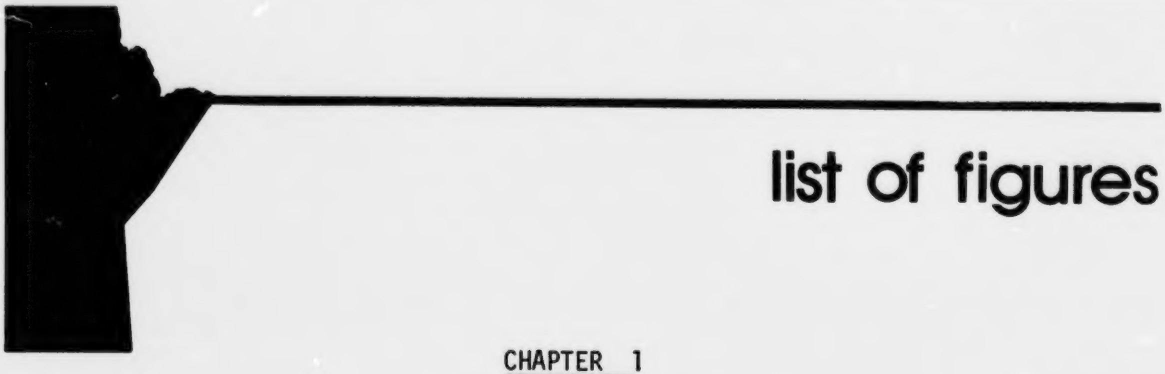
GEOGRAPHY.......................................................... 10-1
LOCATION.......................................................... 10-1
CLIMATE.......................................................... 10-1
PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL.......................... 10-1
VEGETATION.......................................................... 10-3
DRAINAGE PATTERNS.......................................................... 10-3
HUMAN HABITATION.......................................................... 10-3

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE PHYSICAL ENVIRONMENT.......................... 10-4
WATER REGIME CHANGES.......................................................... 10-4
SPLIT LAKE.......................................................... 10-5
NELSON RIVER, FROM SPLIT LAKE OUTLET TO LOWER GULL RAPIDS, AND FROM KETTLE RAPIDS TO HUDSON BAY.......................... 10-5
ICE REGIME CHANGES.......................................................... 10-6
CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER.......................... 10-6
PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS.......................... 10-7
SPLIT LAKE.......................................................... 10-7
NELSON RIVER CHANNEL.......................................................... 10-9

EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION.......................... 10-11
LIMNOLOGY.......................................................... 10-11
FISHERIES.......................................................... 10-11
WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE.......................... 10-12
FOREST RESOURCES AND FORESTRY.......................................................... 10-12
MINERAL RESOURCES AND MINING.......................................................... 10-12
OUTDOOR RECREATION RESOURCES AND THEIR USE.......................... 10-12
ARCHAEOLOGICAL RESOURCES.......................................................... 10-13
TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES.......................... 10-13

EFFECT OF DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE COMMUNITIES.......................... 10-14

SUGGESTED MEASURES TO MITIGATE DETRIMENTAL EFFECTS AND TO ENHANCE BENEFITS IN THE LOWER NELSON RIVER AREA OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG.......................... 10-14



# list of figures

## CHAPTER 1

FIG. 1-1. AGE-SEX DISTRIBUTIONS FOR SELECTED COMMUNITIES AND REGIONS... 1-4

## CHAPTER 2

FIG. 2-1. LOCATION OF GENERATING STATIONS THAT WILL HARNESS THE POTENTIAL OF THE NELSON RIVER AND OF THE DIVERTED FLOWS FROM THE CHURCHILL RIVER.................................... 2-6

FIG. 2-2. PHOTOGRAPH OF KETTLE GENERATING STATION, 1973................ 2-7

## CHAPTER 3

FIG. 3-1. ORGANIZATIONAL FRAMEWORK OF THE LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY............................ 3-2

FIG. 3-2. LOCATION OF STUDY AREAS........................................ 3-7

## CHAPTER 4

FIG. 4-1. LOCATION OF THE MAJOR WORKS TO REGULATE FLOWS FROM LAKE WINNIPEG............................................ 4-3

FIG. 4-2. PHOTOGRAPH OF A HYDRAULIC DREDGE IN OPERATION AT 8-MILE CHANNEL, 1972...................................... 4-4

FIG. 4-3. ARTIST'S CONCEPTION OF JENPEG CONTROL AND GENERATING STATION WHEN COMPLETED....................................... 4-5

FIG. 4-4. PHOTOGRAPH OF JENPEG CONTROL AND GENERATING STATION UNDER CONSTRUCTION, SUMMER, 1974............................. 4-6

FIG. 4-5. LOCATION OF THE MAJOR WORKS TO DIVERT FLOWS FROM THE CHURCHILL RIVER AND OF FUTURE GENERATING SITES............... 4-8

FIG. 4-6. LOCATION PLAN OF MISSI FALLS CONTROL STRUCTURE............... 4-9

FIG. 4-7. PHOTOGRAPH OF THE AREA THAT HAS BEEN CLEARED FOR THE EXCAVATION OF THE SOUTH BAY TO ISSETT LAKE DIVERSION CHANNEL, SUMMER, 1973.................................. 4-10

FIG. 4-8. LOCATION PLAN OF NOTIGI CONTROL STRUCTURE.................... 4-11

## CHAPTER 5

FIG. 5-1. DRAINAGE BASIN OF LAKE WINNIPEG.............................. 5-4

FIG. 5-2. LOCATION OF COMMUNITIES ON LAKE WINNIPEG, 1973............... 5-5

FIG. 5-3. LAKE WINNIPEG WATER LEVELS.................................. 5-7

FIG. 5-4. LAKE WINNIPEG DISCHARGES.................................... 5-9

FIG. 5-5. PHOTOGRAPH OF MARSH AREA AT FOLSTER LAKE, SOUTH OF LAKE WINNIPEG, 1973.............................. 5-11

FIG. 5-6. PHOTOGRAPH OF A TYPICAL SAND BEACH ON THE SOUTH BASIN OF LAKE WINNIPEG, 1973........................... 5-14

FIG. 5-7. LAKE WINNIPEG WATERBIRD NESTING COLONIES AND WATERFOWL HABITAT CAPABILITY............................. 5-22

FIG. 5-8. PHOTOGRAPH OF YOUNG PELICANS AND CORMORANTS ON PIPESTONE ISLAND IN THE SOUTH BASIN OF LAKE WINNIPEG, 1973............. 5-24

FIG. 5-9. PERCENTAGE DISTRIBUTION OF RECREATION ACTIVITY DAYS BY ACTIVITY BY AREAS, LAKE WINNIPEG, SUMMER, 1971............... 5-30

FIG. 5-10. LAND, WATER AND AIR ROUTES AND FACILITIES, LAKE WINNIPEG, 1972.......................................... 5-35

FIG. 5-11. LOCATION OF DYKES AROUND THE SOUTH BASIN OF LAKE WINNIPEG, 1973....................................... 5-40

## CHAPTER 6

FIG. 6-1. SATELLITE PHOTOGRAPH OF THE OUTLET LAKES, SEPTEMBER, 1974.... 6-2

FIG. 6-2. DRAINAGE PATTERN OF THE UPPER NELSON RIVER.................. 6-5

FIG. 6-3. LAND, WATER AND AIR TRANSPORTATION SERVICES AND FACILITIES, OUTLET LAKES, 1973.......................... 6-7

FIG. 6-4. EAST CHANNEL DISCHARGES...................................... 6-10

FIG. 6-5. WEST CHANNEL DISCHARGES...................................... 6-11

FIG. 6-6. PLAYGREEN LAKE (SOUTH BASIN) WATER LEVELS.................... 6-11

FIG. 6-7. PLAYGREEN LAKE (NORTH BASIN) WATER LEVELS.................... 6-11

FIG. 6-8. KISKITTOGISU LAKE WATER LEVELS............................... 6-11

FIG. 6-9. CROSS LAKE WATER LEVELS...................................... 6-14

FIG. 6-10. AREAS WHERE OPEN WATER IS ANTICIPATED TO OCCUR IN WINTER WITH THE REGULATION OF DISCHARGES FROM LAKE WINNIPEG......... 6-17

FIG. 6-11. PHOTOGRAPH OF TYPICAL SHORELINE AROUND CROSS LAKE, 1972...... 6-23

FIG. 6-12. PHOTOGRAPH OF DREDGE SPOIL BEING DEPOSITED BEHIND DYKES AT 8-MILE CHANNEL, 1973.................................. 6-25

FIG. 6-13. ANTICIPATED FUTURE SHORELINE OF KISKITTOGISU LAKE AND 8-MILE CHANNEL WITH AN UNCONFINED CHANNEL................ 6-27

FIG. 6-14. PHOTOGRAPH OF SLUMPING BANKS IN THE VICINITY OF THE ENTRANCE TO 2-MILE CHANNEL, 1972......................... 6-31

FIG. 6-15. MEAN ANNUAL COMMERCIAL FISH PRODUCTION (LB/ACRE) BY SPECIES FROM SEVEN LAKES OF THE UPPER NELSON RIVER SYSTEM, MANITOBA, 1960-1971............................ 6-39

FIG. 6-16. PREDICTED ANNUAL FISH HARVEST POTENTIALS IN THE OUTLET LAKES AREA FOLLOWING HYDROELECTRIC DEVELOPMENT............... 6-43

FIG. 6-17. AERIAL SURVEY OF WATERFOWL STAGING AREAS, OUTLET LAKES, 1972. 6-45

FIG. 6-18. AERIAL SURVEY OF MOOSE, OUTLET LAKES, 1972.................. 6-46

FIG. 6-19. AREAS OF HIGHEST WATERFOWL DENSITY IN THE OUTLET LAKES, FALL, 1972...................................... 6-49

FIG. 6-20. MIGRATION PATTERN OF WOODLAND CARIBOU IN THE OUTLET LAKES, MANITOBA................................ 6-50

FIG. 6-21. MOOSE HARVEST STATISTICS FOR LICENSED HUNTERS (1965-72) AND CARIBOU HARVEST STATISTICS (1969-71) FOR THE OUTLET LAKES AND GAME HUNTING AREA 3......................... 6-53

FIG. 6-22. REGISTERED TRAPLINE SECTIONS AND BLOCKS IN THE OUTLET LAKES, 1972.................................... 6-55

FIG. 6-23. OUTLET LAKES VALUE OF FUR RETURNS FROM MAJOR SPECIES, 1966-67 TO 1970-71....................................... 6-56

FIG. 6-24. TOTAL ANNUAL POTENTIAL FORESTRY HARVEST IN THE OUTLET LAKES, 1972.................................... 6-61

FIG. 6-25. LOCATION OF REFERENCE NUMBERS FOR THE SAMPLE SURVEY OF GOSSAN ZONES, OUTLET LAKES, 1972.......................... 6-66

FIG. 6-26. PHOTOGRAPH OF A SITE ON THE KETTLE RAPIDS RESERVOIR WHICH WAS NOT CLEARED PRIOR TO RAISING THE WATER LEVELS, 1973...... 6-72

FIG. 6-27. LOCATIONS OF THE 1972 ARCHAEOLOGICAL SURVEY IN THE OUTLET LAKES AND OF RECORDED ARCHAEOLOGICAL SITES................... 6-75

FIG. 6-28. PHOTOGRAPH OF THE REMAINS OF A TRADITIONAL NATIVE TRAPPING AND FISHING CABIN AT WHISKEY JACK NARROWS, 1972.............. 6-77

FIG. 6-29. LAND TRANSPORTATION AND PROPOSED ROAD NETWORK EXTENSION, OUTLET LAKES, 1973.............................................. 6-80

FIG. 6-30. WATER TRANSPORTATION SERVICES AND FACILITIES, OUTLET LAKES, 1973.............................................. 6-81

FIG. 6-31. PHOTOGRAPH OF JENPEG ACCESS ROAD AND RUNWAY, 1972............ 6-84

FIG. 6-32. AIR TRANSPORTATION SERVICES AND FACILITIES, OUTLET LAKES, 1973.............................................. 6-85

FIG. 6-33. PHOTOGRAPH OF AERIAL VIEW OF A PORTION OF CROSS LAKE COMMUNITY, 1972.................................... 6-90

FIG. 6-34. PHOTOGRAPH OF AERIAL VIEW OF A PORTION OF NORWAY HOUSE COMMUNITY, 1972.................................. 6-91

FIG. 6-35. PHOTOGRAPH OF AERIAL VIEW OF A PORTION OF WARREN LANDING, 1974.......................................... 6-91

FIG. 6-36. CROSS LAKE COMMUNITY, 1971.................................... 6-92

FIG. 6-37. ESTIMATED PERCENTAGE OF COMMUNITY INCOME BY ACTIVITY AND TYPE OF INCOME FOR CROSS LAKE, 1972-73................... 6-93

FIG. 6-38. GROSS VALUE AND NET INCOME OF FUR HARVESTED OVER THE PERIOD 1967-68 TO 1972-73 BY CROSS LAKE TRAPPERS............. 6-95

FIG. 6-39. CROSS LAKE POPULATION AND LABOUR FORCE DISTRIBUTION, 1973.... 6-97

FIG. 6-40. AGE-SEX DISTRIBUTION OF THE CROSS LAKE POPULATION AND LABOUR FORCE, 1973...................................... 6-97

FIG. 6-41. NORWAY HOUSE-ROSSVILLE COMMUNITY, 1971....................... 6-105

FIG. 6-42. GROSS VALUE AND NET INCOME OF FUR HARVESTED OVER THE PERIOD 1967-68 TO 1972-73 BY NORWAY HOUSE TRAPPERS........... 6-106

FIG. 6-43. NORWAY HOUSE TRAPPING BLOCKS EXPECTED TO BE AFFECTED BY THE LAKE WINNIPEG REGULATION PROJECT...................... 6-107

CHAPTER 7

FIG. 7-1. MAP SHOWING THE LOCATION OF AREA 3 - DIVERSION ROUTE......... 7-2

FIG. 7-2. MAP SHOWING THE DRAINAGE BASINS OF THE CHURCHILL AND NELSON RIVERS PRIOR TO THE DIVERSION PROJECT................. 7-4

FIG. 7-3. MAP SHOWING SURFACE AND AIR TRANSPORTATION SERVICES AND FACILITIES, DIVERSION ROUTE, 1974........................ 7-8

FIG. 7-4. PRE-DIVERSION AND POST-DIVERSION ICE AND WATER REGIME PROFILE OF THE DIVERSION ROUTE........................ 7-10

FIG. 7-5. LOCATION OF ARCHAEOLOGICAL SITES IDENTIFIED DURING THE 1972 SURVEY........................................ 7-40

FIG. 7-6. PHOTOGRAPH OF A NATIVE CREE DANCING CIRCLE, THREEPOINT LAKE, 1972........................................ 7-41

FIG. 7-7. NELSON HOUSE TRAPPING BLOCKS EXPECTED TO BE AFFECTED BY THE CHURCHILL RIVER DIVERSION PROJECT..................... 7-51

## CHAPTER 8

FIG. 8-1. AREA MAP OF SOUTHERN INDIAN LAKE............................ 8-2

FIG. 8-2. AERIAL PHOTOGRAPH OF THE COMMUNITY OF SOUTH INDIAN LAKE, 1973.................................. 8-4

FIG. 8-3. MISSI FALLS DISCHARGES...................................... 8-7

FIG. 8-4. SOUTH BAY DISCHARGES........................................ 8-7

FIG. 8-5. SOUTHERN INDIAN LAKE WATER LEVELS........................... 8-8

FIG. 8-6. MAP OF SHORELINE REACHES OF SOUTHERN INDIAN LAKE............ 8-12

FIG. 8-7. GEOGRAPHIC REGIONS FOR THE LIMNOLOGY-FISHERIES STUDY......... 8-17

FIG. 8-8. THE LOCATION OF PAST AND PRESENT FISH CAMPS ON SOUTHERN INDIAN LAKE........................................ 8-24

FIG. 8-9. TOTAL LANDINGS BY SPECIES FOR THE WINTER FISHERY (1941-42 TO 1971-72)......................... 8-26

FIG. 8-10. TOTAL VALUE TO THE FISHERMEN AND AVERAGE VALUE PER LICENSE FOR THE WINTER SEASONS ON SOUTHERN INDIAN LAKE FROM 1941-42 to 1971-72......................................... 8-28

FIG. 8-11. TOTAL LANDINGS BY SPECIES FOR THE SUMMER SEASONS ON SOUTHERN INDIAN LAKE FROM 1950 to 1971.................... 8-29

FIG. 8-12. GULL NESTING COLONY ON SOUTHERN INDIAN LAKE, 1973............ 8-38

FIG. 8-13. PHOTOGRAPH OF NORTHERN CONIFEROUS ZONE BETWEEN LEAF RAPIDS AND OPACHUANAU LAKE........................... 8-45

FIG 8-14. PHOTOGRAPH OF NORTH-WESTERN TRANSITION ZONE FOREST........... 8-45

FIG. 8-15. MAP OF SOUTHERN INDIAN LAKE REGION TRANSPORTATION SYSTEM..... 8-56

FIG. 8-16. SETTLED AREAS OF SOUTH INDIAN LAKE, 1973.................... 8-63

FIG. 8-17. SOUTH INDIAN LAKE COMMUNITY SOCIAL SYSTEM, 1974.............. 8-75

## CHAPTER 9

FIG. 9-1. LOWER CHURCHILL RIVER AREA.................................. 9-2

FIG. 9-2. PARTRIDGE BREAST LAKE WATER LEVELS.......................... 9-8

FIG. 9-3. NORTHERN INDIAN LAKE WATER LEVELS........................... 9-8

FIG. 9-4. FIDLER LAKE WATER LEVELS.................................... 9-8

FIG. 9-5. BILLARD LAKE WATER LEVELS................................... 9-8

FIG. 9-6. LOWER CHURCHILL RIVER REACHES............................... 9-14

FIG. 9-7. MUSKEG POTHOLES, HUDSON BAY LOWLANDS. CANADA GEESE NEST IN THIS TYPE OF HABITAT AT APPROXIMATELY 5 PAIRS PER SQUARE MILE............................................. 9-26

FIG. 9-8. SMALL STREAM WITH MARSH FRINGE LEADING INTO FIDLER LAKE, LOWER CHURCHILL RIVER. WATERFOWL USE THESE SMALL MARSH AREAS FOR BREEDING AND STAGING.................. 9-26

FIG. 9-9. PAIR OF CANADA GEESE WITH BROOD ALONG ICE-SCOURED SHORELINES, LOWER CHURCHILL RIVER. GEESE NESTING ALONG THE RIVER AND IN ADJACENT MUSKEG PONDS BRING THEIR BROODS TO THE ABUNDANT GRASSES AND SEDGES OF THESE SHORELINES.......... 9-26

FIG. 9-10. GRASSES AND SEDGES ALONG ICE-SCOURED SHORELINE EAST OF BILLARD LAKE, LOWER CHURCHILL RIVER. THIS AREA HAS BEEN USED HEAVILY BY FEEDING CANADA GEESE................ 9-27

FIG. 9-11. STEEP ICE-SCOURED SHORELINE, LOWER CHURCHILL RIVER, AUGUST, 1973. SOME GOOSE ACTIVITY WAS NOTED ALONG THESE SHORELINES, BUT LESS THAN ON MORE GENTLY SLOPING SHORELINES............................................ 9-27

FIG. 9-12. LIMESTONE CLIFFS AT PORTAGE CHUTE RAPIDS, LOWER CHURCHILL RIVER. APPROXIMATELY 20 PERCENT OF THE SHORELINE FROM PORTAGE CHUTE RAPIDS TO RED HEAD RAPIDS IS OF THIS TYPE. VALUE TO MOST SPECIES OF WILDLIFE IS LOW DUE TO STEEP SLOPE AND LACK OF VEGETATION................................ 9-27

FIG. 9-13. LOCATION OF WATER SUPPLY AND WASTE DISPOSAL SYSTEM, CHURCHILL.................................... 9-43

FIG. 9-14. WATER AND ICE LEVELS AT WATER INTAKE PIPE, CHURCHILL......... 9-44

## CHAPTER 10

FIG. 10-1. LOCATION PLAN OF LOWER NELSON RIVER AREA..................... 10-2

# list of tables

## CHAPTER 1

TABLE 1-1. POPULATION ESTIMATES FOR SELECTED NATIVE COMMUNITIES........ 1-3

TABLE 1-2. PERCENTAGES OF INCOME SOURCES IN 1972-73 FOR SELECTED COMMUNITIES: CROSS LAKE, NELSON HOUSE AND SOUTH INDIAN LAKE.... 1-6

TABLE 1-3. ESTIMATE OF CONSTRUCTION WORKERS ON MANITOBA HYDRO'S NORTHERN PROJECTS........................................... 1-10

## CHAPTER 5

TABLE 5-1. LAKE WINNIPEG MEAN MONTHLY WATER LEVELS..................... 5-7

TABLE 5-2. LAKE WINNIPEG MEAN MONTHLY FLOWS............................ 5-10

TABLE 5-3. SUMMARY OF EXCESS RECREATION DEMANDS IN ACTIVITY DAYS, LAKE WINNIPEG, 1980........................................ 5-31

TABLE 5-4. LAKE WINNIPEG JULY AND AUGUST MEAN MONTHLY WATER LEVELS..... 5-32

TABLE 5-5. DEPARTMENT OF PUBLIC WORKS MARINE STRUCTURES ON LAKE WINNIPEG.............................................. 5-37

TABLE 5-6. LAKE WINNIPEG TEMPORARY DYKING SYSTEM SUMMARY TABLE......... 5-41

TABLE 5-7. SUGGESTED MEASURES FOR THE LAKE WINNIPEG AREA TO ENHANCE THE BENEFITS OF THE LAKE WINNIPEG REGULATION PROJECT........ 5-45

## CHAPTER 6

TABLE 6-1. EAST AND WEST CHANNELS MEAN MONTHLY FLOWS................... 6-9

TABLE 6-2. KISKITTOGISU AND PLAYGREEN LAKES MEAN MONTHLY WATER LEVELS.. 6-10

TABLE 6-3. KISKITTO LAKE MEAN MONTHLY WATER LEVELS..................... 6-13

TABLE 6-4. CROSS LAKE MEAN MONTHLY WATER LEVELS........................ 6-13

TABLE 6-5. TOTAL LANDINGS AND VALUES OF THE OUTLET LAKES COMMERCIAL FISHERY, SUMMER 1970 TO WINTER 1973-74...................... 6-37

TABLE 6-6. SUMMARY OF COMMERCIAL FISHING PARTICIPATION, FISH PRODUCTION, AND VALUES TO FISHERMEN FOR OUTLET LAKES, 1960-71.. 6-38

TABLE 6-7. SUMMARY OF GOSSAN OCCURRENCES AND ASSAY RESULTS............ 6-65

TABLE 6-8. PROJECTED JOB VACANCIES BY OCCUPATIONAL GROUPING FOR THE LAKE WINNIPEG REGULATION PROJECT, 1975...................... 6-99

TABLE 6-9. SUGGESTED MEASURES FOR THE OUTLET LAKES AREA TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE LAKE WINNIPEG REGULATION PROJECT........................ 6-111

## CHAPTER 7

TABLE 7-1 NOTIGI RAPIDS PRE-DIVERSION MEAN MONTHLY FLOWS............. 7-8

TABLE 7-2 SOUTH BAY POST-DIVERSION MEAN MONTHLY FLOWS................ 7-8

TABLE 7-3 SUMMARY OF COMMERCIAL FISHERIES QUOTAS AND PRODUCTION ON THE DIVERSION ROUTE LAKES, 1970-72...................... 7-17

TABLE 7-4 AVERAGE ANNUAL FUR HARVEST VALUES AND PERCENT OF LAND AREA AFFECTED IN REGISTERED TRAPPING BLOCKS ALONG THE DIVERSION ROUTE............................................ 7-29

TABLE 7-5 PERCENTAGE COMMUNITY INCOME BY ACTIVITY AND TYPE, NELSON HOUSE, 1972-73.................................... 7-50

TABLE 7-6 NELSON HOUSE REGISTERED TRAPLINE SECTION FUR HARVEST RETURNS AND NUMBER OF ACTIVE TRAPPERS 1967-68 TO 1971-72........... 7-50

TABLE 7-7 GROSS AND NET INCOME OF NELSON HOUSE FISHERMEN, 1969-73..... 7-53

TABLE 7-8 SOURCES OF PERMANENT EMPLOYMENT IN NELSON HOUSE, 1973....... 7-55

TABLE 7-9 NELSON HOUSE LABOUR FORCE, 1972-73......................... 7-56

TABLE 7-10 NELSON HOUSE SKILLS INVENTORY, 1972-73..................... 7-57

TABLE 7-11 RESULTS OF SURVEY ON WILLINGNESS OF NELSON HOUSE RESIDENTS TO RELOCATE....................................... 7-57

TABLE 7-12 SUGGESTED MEASURES FOR THE DIVERSION ROUTE AREA TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE CHURCHILL RIVER DIVERSION PROJECT.......................... 7-67

## CHAPTER 8

TABLE 8-1 SOUTHERN INDIAN LAKE OUTLETS MEAN MONTHLY FLOWS.............. 8-7

TABLE 8-2 SOUTHERN INDIAN LAKE MEAN MONTHLY WATER LEVELS............... 8-8

TABLE 8-3 SOUTHERN INDIAN LAKE SHORELINE CLASSIFICATION SYSTEM......... 8-10

TABLE 8-4 SOUTHERN INDIAN LAKE SHORELINE TYPES (IN MILES).............. 8-13

TABLE 8-5 AREA, VOLUMES, MEAN DEPTHS AND EXCHANGE TIMES OF SEVEN REGIONS OF SOUTHERN INDIAN LAKE AND OPACHUANAU LAKE AFTER DIVERSION.................................................. 8-19

TABLE 8-6 PRINCIPAL SHORELINE TYPES ON SOUTHERN INDIAN LAKE AND THEIR PROBABLE CONTRIBUTION TO SEDIMENTATION AND IMPACT...... 8-21

TABLE 8-7 PARAMETERS INDICATIVE OF GENERAL BIOLOGICAL PRODUCTIVITY OF LAKE REGIONS UNDER PRE- AND POST-IMPOUNDMENT CONDITIONS... 8-21

TABLE 8-8 ANTICIPATED EFFECT OF FLOODING AND DIVERSION ON PRODUCTIVITY OF PARTICULAR FISH SPECIES IN SOUTHERN INDIAN LAKE, PRIOR TO SHORELINE STABILIZATION....................... 8-23

TABLE 8-9 THE AVERAGE LANDINGS PER WINTER SEASON, AVERAGE LANDINGS PER LICENCE, AVERAGE PERCENT WHITEFISH AND AVERAGE PERCENT WALLEYE IN LANDINGS FOR 5 YEAR PERIODS BEGINNING IN THE 1941-42 SEASON............................................ 8-27

TABLE 8-10 AVERAGE VALUE TO THE FISHERMEN, AVERAGE NUMBER OF LICENCES AND AVERAGE VALUE PER LICENCE FOR THE PAST 31 YEARS OF THE WINTER COMMERCIAL FISHING ON SOUTHERN INDIAN LAKE............ 8-27

TABLE 8-11 AVERAGE VALUE PER SEASON, AVERAGE INCOME PER SEASON PER FISHERMEN AND THE AVERAGE NUMBER OF LICENCES PER SEASON FOR THE SUMMER FISHERY FROM 1950 TO PRESENT, AVERAGED OVER 5 YEAR PERIODS............................................. 8-30

TABLE 8-12 THE AVERAGE LANDINGS PER SUMMER, AVERAGE LANDINGS PER SEASON PER LICENCES, PERCENT WHITEFISH AND PERCENT WALLEYE IN CATCH FOR THE SUMMER SEASONS ON SOUTHERN INDIAN LAKE GROUPED IN 5 YEAR PERIODS............................ 8-30

TABLE 8-13 COMMERCIAL YIELD (IN POUNDS) OF WHITEFISH AND WALLEYE FROM DIFFERENT REGIONS OF SOUTHERN INDIAN LAKE (BEFORE) WITH AN ESTIMATE OF COMMERCIAL YIELD OF THESE SPECIES FROM THE SAME REGIONS FOLLOWING DIVERSION AND IMPOUNDMENT (AFTER). VALUES GIVEN FOR THE BEFORE CONDITIONS ARE BASED ON THE RESULTS OF THE 1972-73 WINTER FISHERY AND THE 1973 SUMMER FISHERY.......................... 8-33

TABLE 8-14 SOUTHERN INDIAN LAKE SHORELINE TYPES AND ASSOCIATED WILDLIFE.................................................. 8-35

TABLE 8-15 SOUTHERN INDIAN LAKE REGISTERED TRAPLINE SECTION TRENDS IN FUR HARVEST VALUES 1967-68 TO 1971-72.............. 8-42

TABLE 8-16 SOUTHERN INDIAN LAKE REGISTERED TRAPLINE SECTION TRENDS IN SPECIES FUR HARVEST VALUES, 1967-68 TO 1971-72..... 8-43

TABLE 8-17 SOUTHERN INDIAN LAKE SUMMARY OF LAND TO BE FLOODED BY PRODUCTIVITY AND ZONE (IN ACRES).......................... 8-47

TABLE 8-18 SOUTHERN INDIAN LAKE LOSS OF NET MERCHANTABLE VOLUME THROUGH FLOODING BY ZONE AND DIAMETER CLASS (IN CUNITS)...... 8-47

TABLE 8-19 SOUTHERN INDIAN LAKE LOSS OF THEORETICAL ANNUAL ALLOWABLE CUT THROUGH FLOODING BY ZONE, DIAMETER CLASS AND SPECIES (IN CUNITS)................................................ 8-50

TABLE 8-20 SOUTHERN INDIAN LAKE LOSS OF PRACTICAL ANNUAL ALLOWABLE CUT THROUGH FLOODING BY ZONE, SPECIES AND DIAMETER GROUP (IN CUNITS)........................................... 8-50

TABLE 8-21 SOUTH INDIAN LAKE ESTIMATED INCOMES DERIVED FROM ALL SOURCES, 1972................................................ 8-64

TABLE 8-22 SOUTH INDIAN LAKE PERCENTAGE OF INCOMES DERIVED FROM ALL SOURCES, 1972............................................ 8-64

TABLE 8-23 SOUTH INDIAN LAKE ESTIMATES OF FISHERY INCOME BY PRODUCTION LEVEL................................................ 8-66

TABLE 8-24 SOUTH INDIAN LAKE VALUE OF FUR HARVEST AND NUMBER OF TRAPPERS, 1967/68 TO 1971/72................................ 8-66

TABLE 8-25 SOUTH INDIAN LAKE VALUE OF FUR HARVEST AND NUMBER OF TRAPPERS ON AFFECTED TRAPPING BLOCKS COMPARED WITH TOTAL HARVEST AND TOTAL NUMBER OF TRAPPERS.................................. 8-67

TABLE 8-26 SUGGESTED MEASURES FOR SOUTHERN INDIAN LAKE TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE CHURCHILL RIVER DIVERSION PROJECT........................ 8-78

CHAPTER 9

TABLE 9-1 PHYSIOGRAPHIC REGIONS AND VEGETATION ZONES LOWER CHURCHILL RIVER, MANITOBA (SOUTHERN INDIAN LAKE - HUDSON BAY).......... 9-4

TABLE 9-2 LOWER CHURCHILL RIVER MODIFIED HISTORIC MEAN MONTHLY FLOWS BELOW MISSI FALLS.................................... 9-7

TABLE 9-3 LOWER CHURCHILL RIVER POST DIVERSION MEAN MONTHLY FLOWS BELOW MISSI FALLS........................................ 9-7

TABLE 9-4 LOWER CHURCHILL RIVER LAKES MEAN MONTHLY WATER LEVELS........ 9-9

TABLE 9-5 FUR HARVEST VALUES OF AFFECTED REGISTERED TRAPLINES ALONG THE LOWER CHURCHILL RIVER, 1967-68 TO 1971-72................ 9-31

TABLE 9-6 AVERAGE ANNUAL RETURNS FROM REGISTERED TRAPLINES AFFECTED ALONG THE LOWER CHURCHILL RIVER, 1967-68 TO 1971-72.......... 9-33

TABLE 9-7 SUGGESTED MEASURES TO MITIGATE DETRIMENTAL EFFECTS AND TO ENHANCE BENEFITS IN THE LOWER CHURCHILL AREA OF DIVERSION OF FLOWS FROM THE CHURCHILL RIVER............................ 9-47

CHAPTER 10

TABLE 10-1 NELSON RIVER MEAN MONTHLY FLOWS AT THE OUTLET OF SPLIT LAKE.................................................... 10-4

TABLE 10-2 SPLIT LAKE MEAN MONTHLY LEVELS.............................. 10-5

TABLE 10-3 EXISTING AND ANTICIPATED WATER QUALITY IN THE LOWER NELSON RIVER........................................... 10-8

TABLE 10-4 SUGGESTED MEASURES TO MITIGATE DETRIMENTAL EFFECTS AND TO ENHANCE BENEFITS IN THE LOWER NELSON RIVER AREA OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG................................. 10-15

## chapter 1

# findings and recommendations

## NORTHERN COMMUNITIES

One important contribution of the Lake Winnipeg, Churchill and Nelson Rivers Study is that it has served to focus attention on a large section of Manitoba's northland and its residents and environment. Relative to southern Manitoba, the north is underdeveloped and sparsely populated except for recognized centres such as Thompson, Leaf Rapids and Churchill.

Two distinct types of communities exist in northern Manitoba. One type, such as Thompson, originally developed rapidly around a single resource industry. The other type, the native community, evolved from the traditional pursuits of hunting, trapping and fishing, and developed over several generations.

The industrial communities are largely dependent upon a single industry managed by one predominant organization. They are basically site specific in their resource use, but place demands for recreation and other services on resources which support native communities. The residents of these industrial, urban centres are highly skilled, articulate, and organized to influence governments in the development of their communities.

The residents of native communities are dependent on extensive use of land and water resources for their livelihood. The people settled in their particular locations because of land allocations, abundant fish and game resources (historically if not currently) or for the conveniences offered through early establishment of trading posts. They are less highly skilled than urban residents in the conventional sense of employable skills. Furthermore, the communities in which they live usually lack access facilities. The native community residents, however, are beginning to organize in order to communicate their needs to governments.

There is a basic difference between the two types of communities. The industrial communities developed rapidly and depend entirely on wage economies with strong ties to the general provincial economy and lifestyle. The native communities are relatively isolated from the mainstream of Manitoba life and have just begun to make the difficult transition into the modern industrial age.

In addition, there are fundamental differences between northern native communities and rural communities in the southern part of the province. Northern native communities are separate entities with no surrounding populated area. Southern agricultural centres, on the other hand, have strong social and economic ties with neighbouring rural areas.

As a result of these characteristics, the problems facing northern native communities are distinguishable from those facing other Manitoba centres. Therefore, conventional attitudes which are based on assumptions relevent to southern rural communities are not applicable to northern native communities. Similarly, such native communities cannot be analysed on the same basis as single industry northern communities.

Of the nine communities in the study area, two (Thompson and Leaf Rapids) can be classed as recently established single industry centres, five (Norway House, Cross Lake, Split Lake, Nelson House and South Indian Lake) can be categorized as native communities, and two (Churchill and Ilford) have aspects of both of these categories.

Traditionally the economy of native communities was almost entirely dependent on hunting, fishing and trapping. Increasing populations and competition for the natural resources of the area make it difficult to maintain this reliance on these traditional pursuits.

The latest available estimates (Table 1-1) indicate that there will be a substantial increase in population within northern native communities by 1990. To a limited degree, returns from the resource base can be increased through more efficient use of the fishing, hunting and trapping potential. However, it is unlikely that these limited resources can maintain an increasing population, even at the present standard of living. It would be impossible to achieve and maintain a higher standard of living based on traditional use of natural resources. A major challenge to government will be to prevent future problems from arising due to increasing populations and limited resources.

TABLE 1 - 1
POPULATION ESTIMATES FOR SELECTED NATIVE COMMUNITIES

| | 1971 | 1975 | 1990 |
|---|---|---|---|
| South Indian Lake | 590 | 669 | 1,134 |
| Split Lake | 950 | 1,077 | 1,833 |
| Nelson House | 1,200 | 1,360 | 2,315 |
| Cross Lake | 1,917 | 2,174 | 3,698 |
| Norway House | 2,763 | 3,133 | 5,330 |
| | 7,420 | 8,413 | 14,310 |

Of more immediate concern is the competition between industrial and native communities for the natural resources of the area. Because of their demand for energy and recreation facilities, industrial communities inevitably encroach upon the natural resources available to the native communities. As a result, some residents in the native communities must find alternative means to provide for their social and economic needs. In addition, if the encroachment takes the form of a construction project, the increasing availability of money and goods has an impact on the community's perception of "needs". Thus, the initial contact with a wage economy reinforces the trend away from traditional pursuits. This is particularly true of the young people who show an unwillingness to accept the rigors and low financial returns characteristic of traditional activities.

The problems facing native communities in the north are different from those associated with both northern industrial communities and southern rural centres. In addition, there are some significant differences among the native communities themselves. Although they share some common problems, each community has developed a distinctive lifestyle based on a particular set of circumstances.

## DEMOGRAPHIC RESOURCE BASE

The age and sex distributions of the population in the native communities of northern Manitoba are substantially different from the provincial, northern industrial, and southern rural distributions (Figure 1-1). This unique distribution has significance in terms of the options currently available to the native

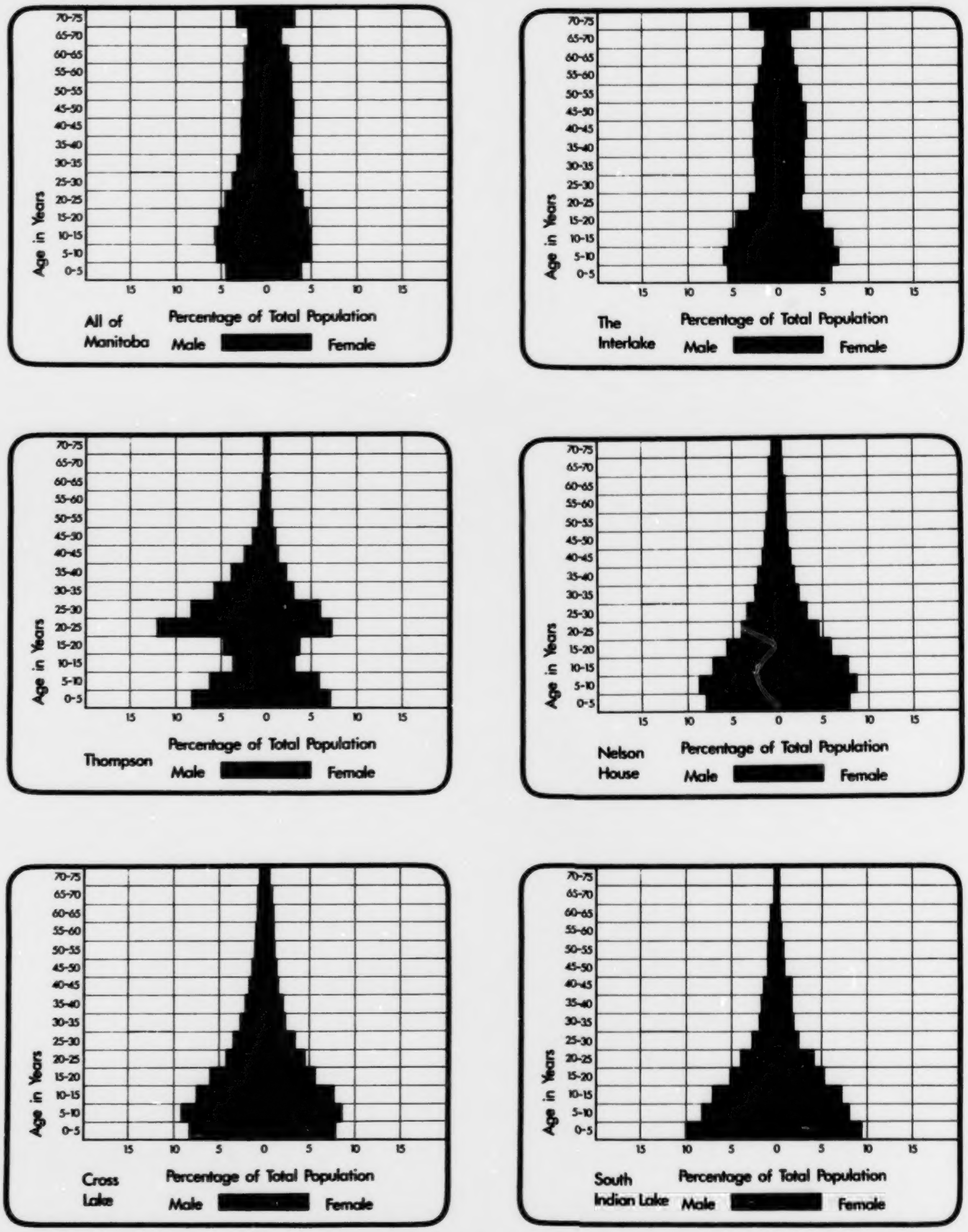


Fig. 1-1. Age-Sex Distributions for Selected Communities and Regions.

community and how these will change as younger residents enter the labour force. For example, approximately 50 percent of the population in most northern Manitoba native communities is under 15 years of age, as compared with 27 percent for Manitoba as a whole, and 31 percent for Thompson.

The high preponderance of future parents implies that, barring a substantial increase in emigration, population in northern native communities will be increasing at an accelerated rate over the next generation. Thus, economic expansion within this region must occur to support the increasing numbers who will be entering the labour force. In addition, the high dependency rate means that in these communities a smaller group of working people is supporting a larger group of dependents than is the case in other Manitoba communities.

## ECONOMIC SUBDIVISIONS

The economy of a native community in the north may be viewed as a composite of three basic elements. These are: the traditional economy based on hunting, fishing and trapping; the wage economy based on work for wages; and, the transfer payment economy based on family allowance, old age pension and social assistance.

The family which works as a unit is characteristic of the traditional economy, whereas the wage economy is based on the individual wage earner.

Since the mid 1960's, the move away from traditional pursuits, combined with the scarcity of alternative economic opportunities, has resulted in transfer payments becoming a significant source of income for residents of northern native communities. In 1972, the average per capita transfer payment for Registered Indian residents in a number of northern communities was approximately $150 as compared with the average for Manitoba as a whole of $65 to $70.

The transition from a traditional society to one based on a wage economy is characterized by a number of changes, both social and economic. Economic data are easier to quantify. The 1972-73 income data for three selected communities that will be affected by hydroelectric developments are provided in Table 1-2. Only about 15 percent of the income of the residents of Cross Lake and Nelson House is derived from the traditional sector. In the case of South Indian Lake, the wage economy accounts for almost as much income as the traditional economy (36% as compared with 37%).

## TABLE 1 - 2
## PERCENTAGES OF INCOME SOURCES IN 1972-1973 FOR SELECTED COMMUNITIES CROSS LAKE, NELSON HOUSE AND SOUTH INDIAN LAKE

| | Cross Lake | | Nelson House | | South Indian Lake | |
|---|---|---|---|---|---|---|
| | 1972/73 Income ($2,194,000) | | 1972/73 Income ($1,279,200) | | 1972/73 Income ($543,800) | |
| **TRADITIONAL ECONOMY** | | | | | | |
| Fishing -Cash | 2.0 | | 1.0 | | 16.0 | |
| -Income in Kind | 6.0 | | 4.0 | | 6.0 | |
| Trapping -Cash | 1.0 | | 1.0 | | 2.0 | |
| -Income in Kind | 1.0 | | 2.5 | | 2.0 | |
| Hunting -Income in Kind | 5.0 | | 2.5 | | 8.0 | |
| Wood Cutting-Income in Kind | 0.0 | | 3.0 | | 4.0 | |
| Sub-Total: | | 15.0 | | 14.0 | | 37.0 |
| **WAGE ECONOMY** | | | | | | |
| Resource Development | | | | | | |
| -Fishery | 0.0 | | 0.0 | | 21.0 | |
| -Forestry | 1.0 | | 0.0 | | 0.0 | |
| -Manitoba Hydro | 29.0 | | 37.0 | | 5.0 | |
| Government | 18.0 | | 19.0 | | 6.0 | |
| Service Industries | 7.0 | | 2.0 | | 3.0 | |
| Sub-Total: | | 55.0 | | 58.0 | | 36.0 |
| **TRANSFER PAYMENT ECONOMY** | | | | | | |
| Government | 30.0 | 30.0 | 28.0 | 28.0 | 27.0 | 27.0 |
| TOTAL: | | 100.0 | | 100.0 | | 100.0 |

NOTE: *The term earned income used throughout the report refers to cash income plus income-in-kind.*

## COMMUNITY ANALYSES

Although the communities of South Indian Lake, Nelson House and Cross Lake are similar in many ways, there are significant differences between them. An obvious disparity is the greater dependence of South Indian Lake on traditional income sources. There are also some major distinctions between the types of wage employment in Cross Lake and those prevalent in Nelson House. In addition, and related to these differences in economic factors, there are significant intercommunity variations in value systems, leadership structures and decision-making processes. The differences between these communities must be recognized in order to avoid the dangers of overgeneralization of problems and its corollary, application of inappropriate solutions to specific local issues.

# IMPLICATIONS FOR NORTHERN MANITOBA

Until recently, the residents of native communities in northern Manitoba have lived within their traditional framework in relative isolation from the remainder of Manitobans. The society within these communities was characterized by an economy based on trapping, hunting and fishing. Because the lifestyle associated with such activities tended to be semi-migratory, the sophisticated community services and facilities characteristic of more sedentary societies were not required.

Within the past 15 to 20 years, a general process of change has reduced this isolation and thrust the communities into a transition towards modernization. Some of the innovations which have had a significant impact on community lifestyle are: the Northern Affairs Act, with its implications for improved municipal services, including a community-council type local government; the adjacent industrial developments in mining and forestry; the development of new modern towns; the increasing accessibility through winter roads, all-weather roads, airstrips and scheduled air flights; and, the increased level of government programs and services.

As the "north" and the "south" become more aware of each other, the disparities between them are recognized. The need for local facilities and services, such as housing, electricity, roads, airstrips, safe water supply, sewage works, garbage disposal, and education and health programs, is now apparent. More significantly, there is an increasing awareness of the urgent need for more employment opportunities and community responsibility in decision-making.

Further, there are indications that northern Manitoba is beginning to develop a regional identity in an economic sense. Due to the increased pace of development over the past 15 to 20 years, a few communities are gradually becoming regional economic centres. This process has been facilitated by the expanding northern road system which links larger more economically viable communities such as Thompson and Lynn Lake to smaller native communities such as Nelson House, as well as to southern Manitoba.

Within the context of transition, hydroelectric development is a catalyst in that it causes the needs of northern communities to surface far more quickly than might otherwise have been the case. Toffler[1-1] describes this state as the "dizzying disorientation brought on by the premature arrival of the future".

The accelerating rate of change has many implications. One dimension of this issue is that some effects are tangible, for example, loss of natural resources, while others, such as change in lifestyle, are intangible. Another dimension is that different effects occur at different stages in the development process.

## IMPACT STAGES

When the hydroelectric projects were announced and prior to any development work, social and psychological problems arose from uncertainty regarding the effects of the developments. During the construction stage, the existence of nearby heavy construction activities suddenly removed the remoteness of these problems. Although new job opportunities developed, many necessary skills were not easily or quickly acquired by local residents. As a result, the jobs went to outsiders. Those who filled these new jobs as well as those who observed them, developed an awareness of an economic system previously encountered only on a sporadic basis, a wage economy, with many implications in terms of lifestyle, including more complex individual, family and community decision-making requirements. Local residents were exposed to the advantages of better facilities (including housing and sewer and water systems). This affected aspirations not only of individuals but of communities. Stress, in combination with improved access and increased incomes, has often led to alcohol-based problems as well as to various forms of social stratification and intra-community tension. Construction workers rapidly increased recreation pressures including hunting. This reduced the supply of "bush" food available, thereby creating demand for expensive replacements.

In the early stages of operation, short-term, tangible and visible effects will become apparent. For example, docks might be flooded or lifted by ice; houses, sheds, or fish stations inundated; traplines flooded or cleared; and, fish nets snagged or fouled by debris. Such effects, by and large, have been identified and, for the most part, have been or are being corrected. Other effects are less easily identifiable. For example, uncertainties in the minds of residents regarding the actual impact will create stress and social tensions that could become manifest in a variety of ways.

Long-term effects depend upon the actual net effects of changes in the water and related resource base as compared with what the situation would have been without the changes. Notwithstanding this simple logic, there will be many who will blame or try to blame all apparent downward trends on the hydroelectric development, even if such trends would have occurred in any case. Critical factors over the long-term are: available and acceptable sources of livelihood; and community decision-making processes capable of handling changes, both predictable and unpredictable, during and following the establishment of a new water regime.

In addition to the more general catalytic effects discussed above, hydroelectric development has created and will continue to affect the important issues of employment and transportation in northern Manitoba.

## TANGIBLE IMPACTS

EMPLOYMENT - The development of the hydroelectric potential of the Nelson River and the diversion from the Churchill River have made large numbers of short-term construction jobs available to northern residents. Estimates of the number of jobs available up to 1982 are provided in Table 1-3. Beyond 1982, development of further sites on the Nelson River and the Diversion Route is expected. It can be speculated that, given the nature of these future projects, the level of employment will continue at approximately 2000 jobs annually until about the year 1990. When these figures are combined with estimates of employment in the two other major sectors, mining and forestry, it appears that approximately 10,000 to 12,000 jobs annually will be available during this time period.

In 1974, the number of people employed on the Lake Winnipeg regulation project peaked at 1385 of which 360 were northern residents and 1025 were workers from other areas. The Churchill River diversion project resulted in 200 northern and 660 other workers being employed at the peak period in 1974.

TABLE 1 - 3
ESTIMATE OF CONSTRUCTION WORKERS ON MANITOBA HYDRO'S NORTHERN PROJECTS

| | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|---|---|
| Long Spruce | 600 | 1,700 | 2,200 | 2,200 | 2,000 | 1,550 | 475 | 250 | - | - |
| Lake Winnipeg Regulation - Jenpeg Project | 1,200 | 1,400 | 800 | 300 | 200 | - | - | - | - | - |
| Churchill River Diversion | 500 | 800 | 500 | - | - | - | - | - | - | - |
| Others | - | 100 | 500 | 800 | 2,000 | 2,000 | 2,000 | 2,000 | 1,500 | 2,000 |
| Total | 2,300 | 4,000 | 4,000 | 3,100 | 4,200 | 3,550 | 2,475 | 2,250 | 1,500 | 2,000 |

SOURCE: *Manitoba Hydro, July,1973.*

The implications to northern Manitoba of these actual and projected employment levels are significant. They appear to indicate that there is at present no job shortage in this area and that there is not likely to be one in the foreseeable future. However, the ability of northern residents to exploit such job opportunities is less clear-cut. The actual levels of employment in the north have had a significant effect on the level of expenditures in this area. Increased income levels have led to expenditures on more consumer goods and services, both in the native communities and, to a greater extent, in centres such as Thompson. However, indications are that such expenditures result in a low multiplier effect since most retail services in this area are owned by outside interests. This is particularly true of the native communities.

Three general activities appear to be necessary: planning; implementation of effective training programs; and modification of the work environment to facilitate local employment.

The planning function must identify future job opportunities and skill requirements and attempt to develop programs to meet them. It is essential that this program take place in consultation with local representatives. Otherwise, lack of local initiative may jeopardize the success of the program. The second function involves an effective and timely training program. A number of experimental programs, which have been implemented in the last few years by the Manitoba Department of Northern Affairs, have met with varying degrees of succe Most of these programs have attempted to integrate the third factor mentioned above, that is, a modified work environment for northern native residents.

TRANSPORTATION - Hydroelectric development has contributed to the acceleration of construction of transportation facilities in northern Manitoba. Some of the roads, airstrips and boat docks have been built specifically to facilitate hydroelectric development. However, in many cases, decisions concerning the provision of transportation infrastructure resulted from a combination of the governments' general northern development policy and specific resource development projects such as mineral exploitation. The Jenpeg access road is an example of a road constructed to facilitate hydroelectric development. The Thompson to Leaf Rapids road falls into the general northern development category. Future road construction along the lower Nelson River can be expected to be, in part, a result of the planned hydroelectric development.

The provision of transportation facilities is, in general, advantageous to the communities under consideration in the study. Reliable, all-weather road links to Cross Lake and South Indian Lake are more feasible because of the closer proximity of new roads. Cross Lake is within 15 miles of the Jenpeg access road, and South Indian Lake is within 17 miles of the all-weather road into the South Bay construction site. Nelson House has a road link as a result of construction of the Thompson to Leaf Rapids road. In addition, the Thompson to Gillam road, now under construction, will link Split Lake with the rest of the northern Manitoba region.

These present and proposed actions have implications relative to the development of an employment strategy in this region and the reduction in the cost of goods and services provided in these communities. The existence of all-weather road links can increase the mobility of the local labour force which will enable fuller exploitation of the job opportunities discussed earlier. In addition, road links could substantially reduce the costs of fuel, food and other commodities in these communities. The reliability inherent in all-weather roads could facilitate the uninterrupted supply of such basic community needs. Further, reliable access provides better prospects for the development of tourism.

In general, hydroelectric development has had a beneficial impact on the development of transportation infrastructure in northern Manitoba. These beneficial impacts resulted directly from the construction of new roads and other transportation facilities, and indirectly from improvements in existing transportation services. The Thompson to Leaf Rapids extension of Provincial Road 391 and improvements in air services in the north are examples of indirect benefits.

NATURAL RESOURCE UTILIZATION - The Lake Winnipeg regulation and Churchill River diversion projects will have a negligible impact on natural resource utilization in the northern Manitoba economy with the exception of the commercial fishery which is expected to experience some long-term losses in productivity. This conclusion should not detract from the more substantive study findings concerning disruption of local economic and social patterns.

Commercial Fishery - The commercially fished waters that will be influenced by the hydroelectric projects comprise Lake Winnipeg, the Outlet Lakes, Southern Indian Lake and the lakes in the lower Churchill River. The fishery along the Diversion Route is negligible from a commercial viewpoint although it does make a significant contribution to the local economy as income-in-kind (a food source). Of the lakes fished, Lake Winnipeg is by far the most important from a commercial production aspect followed by Southern Indian Lake and the Outlet Lakes. In the 1972-73 fishing year approximately 35 percent of Manitoba's 20,000,000 pounds of fish came from Lake Winnipeg. Southern Indian Lake contributed about 5 percent, the Outlet Lakes contributed about 3 percent and the remaining lakes in the study area added another one percent to the provincial total.

Fish populations in Lake Winnipeg will likely be unaffected by the regulation project and the availability of commercial species to standard commercial fishing gear is likely to remain unchanged. The Lake Winnipeg regulation project will, however, create minor short-term disruptions to the fishing operations in the Outlet Lakes region, but no ongoing losses to the fishery are expected. These disruptions will occur until the fishermen adapt to the changes in fish migration patterns between Lake Winnipeg and Playgreen Lake, and to the expected new fish migration between Playgreen Lake and Kiskittogisu Lake.

The fishery of the lower Churchill River lakes will likely cease to be commercially viable after the Churchill River diversion project is in operation. Although this local fishery yields only about 100,000 pounds per year and is insignificant in terms of the total Manitoba yield, it is significant to the community of Ilford as it represents 30 percent of the landed value of the Ilford Co-operative Limited. The diversion project will also reduce the long-term biological productivity of Southern Indian Lake by approximately 10 percent. Although calculations show that the current fishing potential of Southern Indian Lake is not fully realized, the 10 percent reduction in productivity will result in less fish caught per unit effort by the local fishermen from South Indian Lake. In addition to lower fish populations, the fishermen on Southern Indian Lake will face an increased number of hazards from floating debris and from more difficult access to the shoreline in case of emergency.

Wild Fur Industry - Trapping in the study area contributes about 7 percent to the total wild fur value in Manitoba (based on 1972-73 figures). It is anticipated that the hydroelectric development will have a minor but detrimental impact on this industry. In general, registered traplines in the areas of Norway House, Cross Lake, Nelson House, South Indian Lake and the lower Churchill River are expected to experience short-term losses in production. In a few cases, notably in the Cross Lake area and along the lower Churchill River, disruptions may be ongoing. An indication of the most extreme losses possible can be obtained by assuming that any registered trapline which is disrupted will lose 100 percent of its production. Under this extreme assumption, the value of the Manitoba fur harvest would be reduced by only 3 percent. More realistically, it can be expected that these impacts will be much less severe. It must be stressed, however, that as in the fishing industry the impact on the wild fur industry is significant to the local communities in both an economic and social sense.

Mining - Forestry - Mining and forestry are two important sectors in the economy of northern Manitoba. Mining activity centres around Thompson, Lynn Lake, Leaf Rapids and Flin Flon while forestry operations throughout the north are, for the most part, connected with the Manitoba Forestry Resources Ltd pulp and paper and lumber plants near The Pas. Geological and forestry studies indicate that the hydroelectric development will not result in any significant impacts to these sectors. Exploitation of mineral deposits should not be significantly hampered by flooding and the timber lost through inundation will not adversely affect present commercial forestry operations in the north. On the other hand, the improvements to the transportation system in the area will be an advantage to the forest industry.

## INTANGIBLE IMPACTS

There are three intangible impact issues which apply to northern native communities generally: social stress, nutrition and cultural change.

SOCIAL STRESS - The stress which accompanies rapid change is referred to throughout this report. The importance of this social stress should not be underestimated.

NUTRITION - Among the difficulties facing communities within the study area, there is the problem of maintaining adequate nutritional levels.

In the past, northern Manitoba native communities relied heavily on land food such as meat, fish, and berries for their nutrient supply. Purchases of foods other than such staples as flour and salt were infrequent. With the transition from a gathering society to a partial wage economy, this pattern has been undergoing a change. Local residents have more money with which to buy a wider variety of foods, and less time and perhaps less inclination and incentive to hunt and fish. Under such circumstances, they tend to rely more and more on purchased foods. In the absence of adequate nutrition education, this shift in consumption patterns can have a serious effect on health. This occurs when residents consume less protein-rich land food and more candy and soft drinks.

CULTURAL CHANGE - As industrialization of the north increases, residents become increasingly influenced by the convenience and material goods associated with a different way of life. Gradually social and cultural values are altered so as to approach those prevalent in industrialized societies. Second and third generation residents are thus apt to lose interest in the traditional rituals and artifacts which had been an integral and functional part of earlier community life. At some point, however, developing societies regret the loss of this link with their past and seek to preserve the remnants of a vanishing culture. The timeliness of this reawakening interest in cultural roots is particularly significant since valuable information will be lost when the pioneer generation dies out. In northern Manitoba native communities, the number of older residents who have information which is crucial to the preservation of native culture is diminishing. In this respect, as in other aspects of community life, hydroelectric development is a significant factor, since it accelerates the rate of cultural change. This could result in a serious loss to the communities concerned, to Indian culture as a whole, and to the province generally.

# RECOMMENDATIONS

Allocation of existing natural resources for alternative uses and among competing user groups is probably the greatest problem facing resource managers today. The confrontation between wilderness advocates and commercial developers bears witness to this problem. Since benefits and costs from alternative resource uses may accrue to different groups in our society, it is important that the distribution of benefits and costs be examined in detail. Who are the principal recipients of the benefits, and who bears the burden of the costs? Failure to identify the beneficiaries of resouce allocation decisions can readily result in a transfer of benefits to one particular group in our society at a cost to another.

Manitoba Hydro is a public utility. It is a corporate "creature of state" which has the provision of electrical service at least cost as its prime motive. As a Crown Corporation, the residents of Manitoba may be regarded as "stock holders" in Manitoba Hydro in much the same way as they may be regarded as "stock holders" in Manitoba's natural resources. Therefore, additional costs to Manitoba Hydro to compensate for displaced resource productivity should be equated only to the value of the displaced resource. Private property damages, lifestyle disruptions and income losses resulting from displaced resources, however, should be compensated. To do otherwise would distribute or transfer costs to a specific group of Manitobans.

It is within this context that the Lake Winnipeg, Churchill and Nelson Rivers Study Board developed its recommendations.

A final point to note in understanding the perspective in which the recommendations were made is the fact that the study was undertaken concurrently with the hydroelectric development. To provide the maximum amount of lead time for problem-solving, information on specific impacts and actions were recommended during the conduct of the study. Thus, many of the recommendations contained in this report have been acted upon or are under active examination. The recommendations in these categories have been noted.

The Lake Winnipeg, Churchill and Nelson Rivers Study Board recommends the following actions to the Minister of the Environment, to the Minister of Mines, Resources and Environmental Management, and to Manitoba Hydro:

1. THAT a body with broad representation be established to advise on the management of the waters affected by the regulation of Lake Winnipeg, and the diversion of flows from the Churchill River, with the view to ensuring the optimum utilization of the resources within the area influenced by these waters.

   The functions of this body would be to advise on

   (a) patterns of regulation for the levels of Lake Winnipeg and flows from Southern Indian Lake taking into consideration all resources and recognizing the terms of licences granted to Manitoba Hydro for regulation of Lake Winnipeg and diversion of flows from the Churchill River,

   (b) the development of a comprehensive resource management plan for the area affected by the hydroelectric projects, and

   (c) the implementation of the plan

2. THAT a flow forecasting program be developed from which projections of inflows to Lake Winnipeg and Southern Indian Lake can be made.

3. THAT Manitoba Hydro and other resource developers provide just compensation or mitigation for all damages resulting directly from the developments.

4. THAT a special appeal mechanism be established to which unresolved compensation issues can be referred for adjudication.

5. THAT a mechanism be established to deal with social and related economic issues including:

   (a) information and communication problems related to hydroelectric development with particular emphasis on the alleviation of social psychological stress,

   (b) mitigation and compensation issues, and

(c) monitoring and analysis of ongoing social and economic changes related to hydroelectric development and, more generally, northern development.

6. THAT federal and provincial government departments and agencies, with special emphasis on consultation with northern residents, develop a long-term northern development program to deal with the needs of northern Manitoba communities including:
   (a) the provision of technical assistance to community councils for the development of decision-making, problem-solving, communications and community life skills; and,
   (b) the establishment of guidelines outlining "developer" roles and responsibilities to clarify and make known the responsibility of potential developers to compensate for effects on infrastructures, livelihood, lifestyle and local employment as well as to manifest a respect for cultural differences, local authority, community decision-making and communication processes.

7. THAT the concerns of northern residents be more meaningfully recognized and considered in the planning and implementation of resource development projects.

8. THAT a more comprehensive information dissemination program be implemented to inform residents of northern settlements of resource development activities and likely implications to their communities.

9. THAT, where local residents prefer to pursue traditional lifestyles and where it is possible to do so, opportunities to follow such a lifestyle be provided.

10. THAT appropriate government departments and agencies develop and implement a long-term co-ordinated ecological monitoring and research program to allow impact evaluation and to assist in the ongoing management of the affected area.
    This recommendation was transmitted to the Ministers and to Manitoba Hydro during the course of the study.

11. THAT a clean-up and restoration program be carried out at all construction

sites and construction campsites after the activities have terminated and the camps vacated.

12. THAT debris control programs be developed and implemented where required in project areas in consultation with local community representatives.

13. THAT an ice cover monitoring program be established to identify safe over-ice crossings in the vicinity of the communities of Cross Lake, Split Lake, Nelson House and South Indian Lake, and along all winter roads where they cross lakes and rivers affected by the projects, and to identify and mark areas where ice crossings may be hazardous.

14. THAT, prior to impoundment, clearing be completed in general accordance with the program developed by the Timber Salvage and Clearing Committee of the Manitoba Department of Mines, Resources and Environmental Management.

15. THAT Manitoba Hydro mark newly created hazards to navigation on existing transportation routes and in float plane landing area.

16. THAT additional cultural centres or museums be established in northern Manitoba with a view to preserving native cultural heritage.

17. THAT community traplines affected by the projects be reestablished to a condition acceptable to local community councils or that some mutually acceptable alternative be provided.

18. THAT local people traditionally dependent on hunting in the area around construction camps be permitted to continue to hunt in these areas.

19. THAT treed zones be maintained between construction sites (such as borrow pits) and road or water routes.
    This recommendation was transmitted to the Ministers and to Manitoba Hydro during the course of the study.

## LAKE WINNIPEG

20. THAT a handbook be developed, published and distributed for the purpose of
    (a) providing interested citizens with information on Lake Winnipeg levels and rates of shoreline recession, and
    (b) assisting lakeside property owners in the construction and maintenance of suitable shoreline protective works.

21. THAT an experimental program be undertaken to demonstrate methods of developing and maintaining sand beaches along the shores of the south basin of Lake Winnipeg by constructing three or four sand beaches each approximately 400 ft long.

22. THAT the federal and provincial government departments and agencies co-operate to develop marsh management techniques and a management program for the Netley and Libau marshes.

23. THAT an embankment material evaluation program be undertaken to provide full information on the condition of the temporary dykes around Lake Winnipeg.

24. THAT the current program of dyke maintenance on Lake Winnipeg temporary dykes be continued and further measures be considered for sections of the dyking system which are continually subjected to erosion by wave action.

## OUTLET LAKES

25. THAT an all-weather road be built connecting the Cross Lake community road network with the Jenpeg access road.

26. THAT consideration be given to establishing a temporary fish handling station, docking facilities and a regular truck pick-up at the mouth of the Minago River for trucking commercial fish to Wabowden.

27. THAT consideration be given to managing the level of Cross Lake within a fluctuation range of two feet during the November-December flow cutback period at Jenpeg.

28. THAT, if disruptions to boat accessibility from Cross Lake to Walker Lake and to Drunken Lake occur, a mitigation program be implemented.

29. THAT resource management and resource agencies investigate further the operational aspects of the Kiskitto Lake regulation works to determine optimum water levels for fish, wildlife and recreation resources. This recommendation was transmitted to the Ministers and to Manitoba Hydro during the course of the study.

30. THAT the fish attraction and holding device now installed at Jenpeg be operated for two years to determine the need for a permanent fish passage facility.

## SOUTHERN INDIAN LAKE

31. THAT fish populations and biological productivity be monitored until populations and productivity have stabilized after the diversion project has been implemented, and that the necessary minimum annual discharge at Missi Falls be determined to maintain fish populations and productivity at an acceptable level in the northern portion of the lake.

32. THAT the all-weather access road from Ruttan Lake to South Bay be maintained and a means of year-round access be provided from that road to the community of South Indian Lake.

33. THAT the initial impoundment on the lake begin after mid-July to minimize loss of nesting waterfowl, gulls and terns, and muskrats.

## DIVERSION ROUTE

34. THAT Manitoba Hydro, the community of Nelson House and appropriate federal and provincial government departments and agencies continue negotiations to deal with issues arising from the flooding of Indian Reserve Lands at Nelson House.

35. THAT the Birchtree Mine and Thompson water supply pumphouses and the outfall from the main sewage plant at Thompson be modified prior to flooding to accommodate the projected high water level.
This recommendation was transmitted to the Ministers and to Manitoba Hydro during the course of the study.

36. THAT consideration be given to the acceleration of the construction scheduling of the Burntwood River power plants.

37. THAT Manitoba Hydro examine the feasibility of constructing the Manasan power development in such a manner as to preserve the falls and adjacent area for a heritage park.

38. THAT a research program be undertaken to evaluate the ecological implications of the various timber clearing methods used in the Notigi reservoir.

39. THAT the appropriate Manitoba government departments, in consultation with Manitoba Hydro, designate areas in the vicinity of the Notigi dam which could be utilized for recreation purposes.

40. THAT all floating debris be prevented from entering the vicinity of the float plane base at Thompson to ensure safe conditions for aircraft.

41. THAT affected sections of Provincial Road 391 and of the Nelson House access road be raised or re-routed prior to being affected by diversion flows.
This recommendation was transmitted to the Ministers and to Manitoba Hydro during the course of the study.

### Lower Churchill River

42. THAT adequate flows be maintained in the lower Churchill River to provide a suitable municipal water supply for the community of Churchill until such time as an alternative method of maintaining a satisfactory water supply is available.
This recommendation was transmitted to the Ministers and to Manitoba Hydro during the course of the study.

43. THAT, during the initial phase of diversion, the flow down the Churchill River be reduced gradually over a period of two or more years and that appropriate government departments and agencies monitor the levels and flows in the river system in order to establish criteria for flow releases from Missi Falls.

44. THAT appropriate government departments and agencies initiate a study to determine the desirability and feasibility of increasing the range of fluctuation on Southern Indian Lake to improve the flow regime in the lower Churchill River.

45. THAT water depths upstream of Mosquito Point be maintained for boating and boat access to the cottage areas used by the residents of Churchill or suitable alternatives be provided.

46. THAT appropriate government departments and agencies determine the advisability of controlling levels on the lakes on the lower Churchill River.

47. THAT water releases at Missi Falls be as steady as possible in May and June to minimize damage to nesting waterfowl downstream.

# FOOTNOTES

[1-1] Toffler, A., "Future Shock" Bantam: New York, 1970.

# chapter 2

# introduction and background

## INTRODUCTION

The Nelson River hydroelectric development program is being undertaken by the government of Manitoba to utilize the Nelson and Churchill rivers in Manitoba for production of electrical energy. The program will develop the potential of the Nelson River by regulating and augmenting its flows, by constructing generating stations to harness its power potential, and by expanding transmission facilities to carry the power.

The governments of Manitoba and Canada, recognizing the need for coordinating and considering all interests related to the use of the water for energy purposes, initiated a study to determine the effects of three components of the Nelson River development program: the regulation of Lake Winnipeg; the diversion of flows from the Churchill River; and the construction of generating stations along the Burntwood River, a tributary of the Nelson River.

The Study assessed the effects of the regulation and diversion works on the environment, resources and resource utilization, and communities within the area. Implications to the people and the environment in the affected areas were identified, and measures to increase overall benefits and mitigate detrimental effects have been recommended.

The Nelson River hydroelectric development program provides for the regulation of Lake Winnipeg between elevations 711 ft and 715 ft by 1975, and for diversion of up to 30,000 cubic feet per second (cfs) of the flow from the Churchill River by 1977. The diverted Churchill River water will follow a route from South Bay on Southern Indian Lake to the Rat River which is tributary to the Burntwood River which in turn joins the Nelson River at Split Lake. The economic and technical feasibility of this power development program and its components was not examined in the Study. The decision to undertake development of the Nelson River, and to proceed with the regulation of Lake Winnipeg and diversion from the Churchill River was made by the government of Manitoba prior to initiation of the Study. However, the history of the development program is essential to understanding the relationship between the Lake Winnipeg, Churchill and Nelson Rivers Study, and the Nelson River development program.

This chapter briefly reviews the events which led to the Nelson River development program, beginning with Manitoba Hydro's role in formulating the program, the granting by the provincial government of interim licences to Manitoba Hydro to proceed with specific components of the program, and concluding with the Agreement between the governments of Manitoba and Canada which authorized the establishment of the Lake Winnipeg, Churchill and Nelson Rivers Study Board.

## MANITOBA HYDRO'S ROLE

Manitoba Hydro is the provincial Crown Corporation responsible for providing the electricity necessary to meet the demands of the people and of the economy of Manitoba. Manitoba Hydro undertakes studies to predict future demands and to determine future supplies through expansion of generating and transmission facilities. As stated in the Manitoba Hydro Act, Manitoba Hydro is required:

> *...to provide for the continuance of a supply of power adequate for the needs of the Province, and to promote economy and efficiency in the generation, distribution, supply, and use of power...*

At least once a year, Manitoba Hydro prepares a 10-year forecast of Manitoba's electrical energy demands. These forecasts are based on past trends in purchases of electrical energy. Studies into methods of expanding generating and transmission facilities are based on a 20 to 30-year period. By combining the results of these studies, Manitoba Hydro establishes a development plan.

Management of this provincial utility is under the authority of the Manitoba Hydro-Electric Board which reports to the Legislative Assembly of Manitoba through a provincial minister charged with this responsibility. Programs and projects for the generation and transmission of electricity are submitted through the minister responsible for approval by the government of Manitoba. Utilization by Manitoba Hydro of water resources within Manitoba, and the construction of necessary works for the generation of hydroelectricity require the issuance of the necessary licences by the provincial and federal governments.

Demands for electrical energy have been increasing steadily in the province with expansion and diversification of economic activities. According to forecasts prepared by Manitoba Hydro, demand will double during the next decade to approximately 23,000,000,000 kilowatt hours in 1984. Manitoba Hydro has examined different methods of meeting the projected demand, including construction of hydroelectric, nuclear, or fossil fuel generating facilities, and the purchase of power from neighbouring electrical systems. With authorization of the provincial government, Manitoba Hydro is expanding electrical output capacity by developing the hydroelectric potential of the Nelson River.

## HISTORY OF NELSON RIVER HYDROELECTRIC DEVELOPMENT PROGRAM

In 1963 and 1964 the governments of Manitoba and Canada entered into agreements for joint studies to investigate the hydroelectric potential of the Nelson River. Costs of the studies were shared equally between the governments with Manitoba's share being paid by Manitoba Hydro. The studies recommended that development of the Nelson River be undertaken by construction of four major components: high voltage transmission facilities to transport Nelson River power to southern Manitoba; generating facilities at Kettle Rapids; works to enable diversion of substantial flows from the Churchill River into the Nelson River; and works to regulate Lake Winnipeg at its outlet.

Both governments accepted the recommendation to proceed with the hydroelectric development of the Nelson River, and in 1966 a third agreement was signed to proceed with construction of the transmission facilities. Under this agreement the federal government financed the construction of a 900,000 volt direct current transmission system as its contribution to the development program of the Nelson River. The transmission facilities were constructed by Atomic Energy of Canada Limited (AECL), a federal Crown Corporation acting as the designated agent on behalf of Canada. Manitoba Hydro is operating this system and is obligated to reimburse the government of Canada for the cost of the system over a period of not more than 50 years.

In 1966 work also began on construction of generating facilities at Kettle Rapids. Power was first produced in December, 1970, and the final generator was completed in 1974. The generating station has an electric output capacity of 1,272,000 kilowatts.

Before construction could begin on the works for regulation of Lake Winnipeg and diversion from the Churchill River, detailed investigations were required. Studies on diversion works began in 1966, and continued throughout 1967. Investigations of works required for regulating Lake Winnipeg were to be undertaken at a later date.

Following completion in 1968 of the studies of the diversion from the Churchill River, Manitoba Hydro announced a plan to raise the level of the waters of the Churchill River at Southern Indian Lake by approximately 35 ft and to divert a substantial portion of the Churchill River flow into the Nelson River via the Rat and Burntwood rivers.

A provincial government task force reviewed this proposal and concluded that it would depreciate the natural resources base of northern Manitoba, and would necessitate the relocation of the communities of Pickerel Narrows on Granville Lake, and of South Indian Lake on Southern Indian Lake.

Strong criticism of the high-level diversion plan was voiced at public hearings held in 1969 at South Indian Lake and Winnipeg. The government of Manitoba concluded that the high water levels proposed in this plan for Southern Indian Lake were socially unacceptable. This led to joint efforts between Manitoba Hydro and the provincial government to formulate an alternative plan. The provincial government funded a study to examine the feasibility of regulating the flow pattern of the Nelson River by controlling the discharges from Lake Winnipeg and using the lake as a storage reservoir enhancing the production capability of generating stations to be constructed on the Nelson River.[2-1] Manitoba Hydro funded studies to investigate alternative methods of diverting substantial flows from the Churchill River.[2-2]

The findings of these studies, and those of investigations into other possible methods of supplying the amount of electric energy to meet Manitoba's forecast demand, were reviewed by a Manitoba Hydro task force.[2-3] The task force concluded that by combining the regulation of Lake Winnipeg with a plan for diversion from the Churchill River, Manitoba's demand for electrical energy could be accommodated satisfactorily. Under this proposal, Lake Winnipeg would be regulated between elevations 711 and 715 ft, a maximum of 30,000 cfs would be diverted from the Churchill River, and the level of Southern Indian Lake would not be raised above elevation 850 ft.

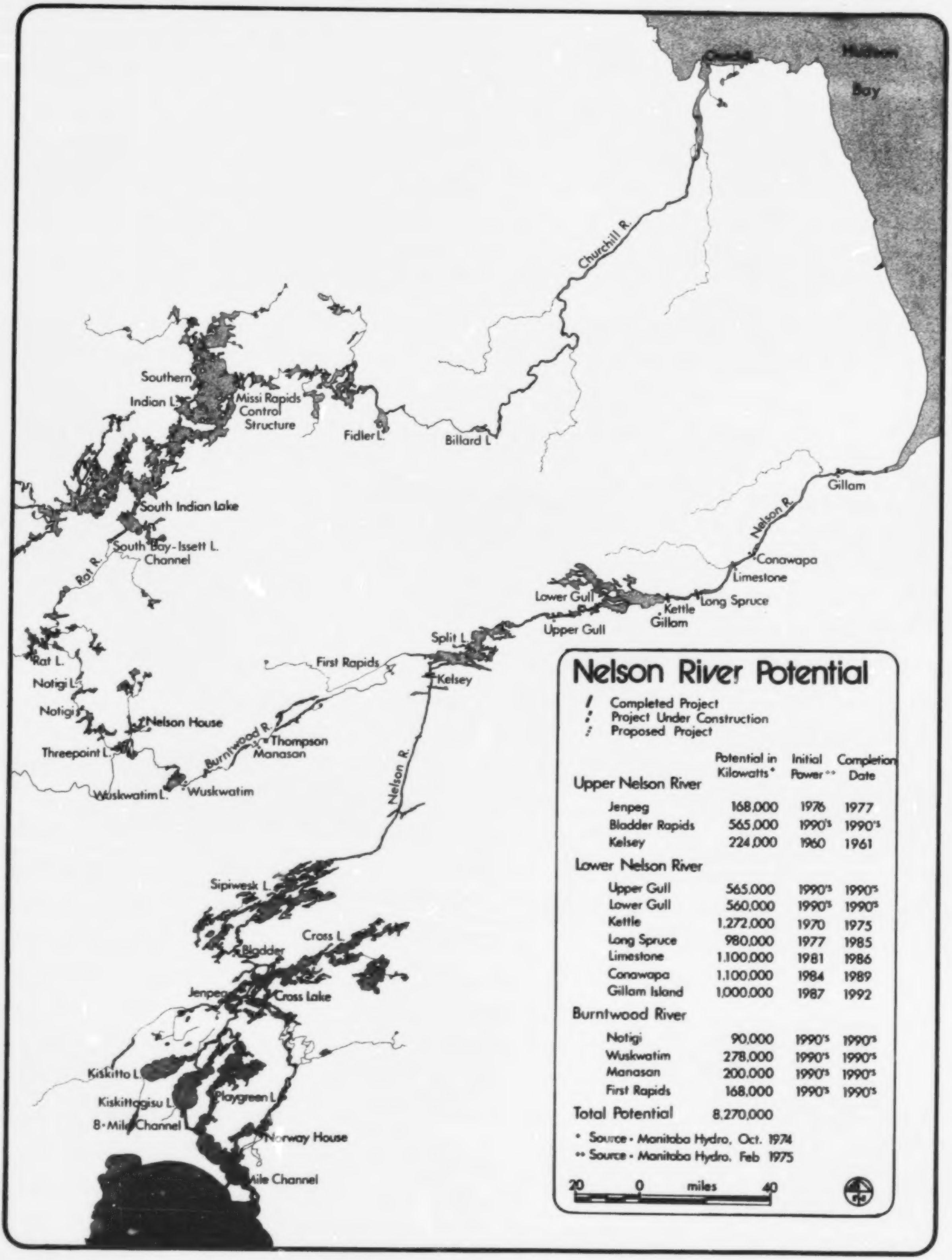
The provincial government approved the program to regulate Lake Winnipeg and to divert flows from the Churchill River based on these findings. In November, 1970, the government issued an interim licence to Manitoba Hydro to proceed with the construction of works required to regulate Lake Winnipeg. An amendment to this licence in May, 1972, permitted a change in the location of the control works. Originally, control was to be effected by two gated structures: one at Metchanais Rapids and one at Ominawin Rapids. The amendment authorized the control structure to be located at the outlet of the West Channel of the Nelson River into Cross Lake at a site known as Jenpeg.

In December, 1972, the provincial government issued an interim licence to Manitoba Hydro authorizing the construction of works associated with the diversion from the Churchill River. A new licence was issued in May, 1973, which permitted the control structure at Missi Falls to be located on the south channel rather than on the north channel as originally proposed.

A total of fourteen sites has been identified by Manitoba Hydro as locations for generating stations to harness the potential of the Nelson River and of the diverted flows from the Churchill River (Fig. 2-1). Construction of stations at these identified sites would increase Manitoba's power production capacity by about 8,000,000 kilowatts, or by an amount equal to three times the 1973-74 installed capacity.

Stations at two of the fourteen sites, Kelsey and Kettle, have been completed and two more are under construction. Kelsey was completed in 1961 to supply electrical energy for the nickel mining/smelting/refining operation at Thompson. Kettle (Fig. 2-2) was completed in 1974. Generating stations at Jenpeg and Long Spruce are under construction. It is expected that completion of power producing facilities at these sites will meet Manitoba's energy requirements to 1980.

The tentative schedule of construction proposed for the remaining ten sites is shown in Fig. 2-1. Four of these sites, Notigi, Wuskwatim, Manasan and First Rapids, are along the Rat-Burntwood Diversion Route which is a tributary of the Nelson River; six sites are along the Nelson River: Bladder, Upper Gull, Lower Gull, Limestone, Conawapa, and Gillam Island. Site investigations for development of Limestone are underway.


Churchill
Hudson Bay
Churchill R.
Southern Indian L.
Missi Rapids Control Structure
Fidler L.
Billard L.
South Indian Lake
South Bay-Issett L. Channel
Rat R.
Rat L.
Notigi L.
Notigi
Nelson House
Threepoint L.
Burntwood R.
Thompson
Manasan
Wuskwatim L.
Wuskwatim
First Rapids
Split L.
Kelsey
Nelson R.
Lower Gull
Upper Gull
Kettle
Gillam
Long Spruce
Limestone
Conawapa
Nelson R.
Gillam
Sipiwesk L.
Cross L.
Bladder
Jenpeg
Cross Lake
Kiskitto L.
Kiskittogisu L.
Playgreen L.
8-Mile Channel
Norway House
Mile Channel
20
0
miles
40

**Nelson River Potential**

- / Completed Project
- ⁄ Project Under Construction
- ⁄ Proposed Project

| | Potential in Kilowatts* | Initial Power** | Completion Date |
|---|---|---|---|
| Upper Nelson River | | | |
| Jenpeg | 168,000 | 1976 | 1977 |
| Bladder Rapids | 565,000 | 1990's | 1990's |
| Kelsey | 224,000 | 1960 | 1961 |
| Lower Nelson River | | | |
| Upper Gull | 565,000 | 1990's | 1990's |
| Lower Gull | 560,000 | 1990's | 1990's |
| Kettle | 1,272,000 | 1970 | 1975 |
| Long Spruce | 980,000 | 1977 | 1985 |
| Limestone | 1,100,000 | 1981 | 1986 |
| Conawapa | 1,100,000 | 1984 | 1989 |
| Gillam Island | 1,000,000 | 1987 | 1992 |
| Burntwood River | | | |
| Notigi | 90,000 | 1990's | 1990's |
| Wuskwatim | 278,000 | 1990's | 1990's |
| Manasan | 200,000 | 1990's | 1990's |
| First Rapids | 168,000 | 1990's | 1990's |
| Total Potential | 8,270,000 | | |

* Source - Manitoba Hydro, Oct. 1974
** Source - Manitoba Hydro, Feb 1975

Fig. 2-1. Location of Generating Stations that will Harness the Potential of the Nelson River and of the Diverted Flows from the Churchill River.

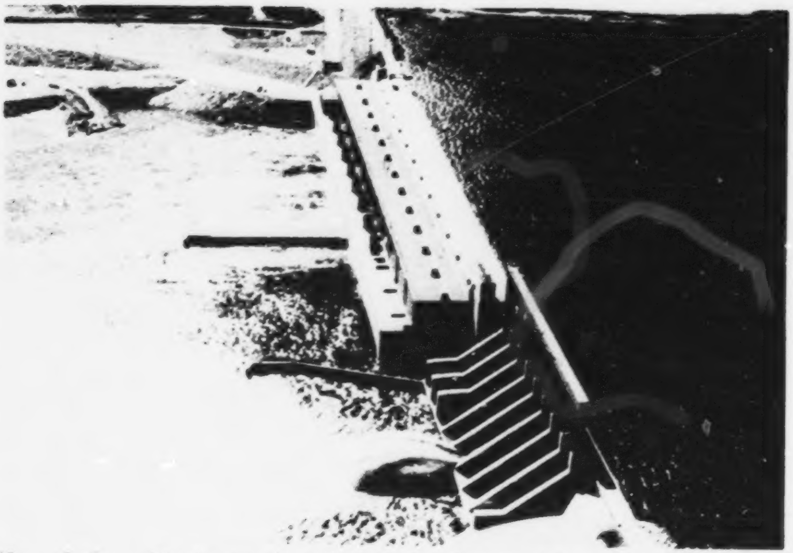


Fig. 2-2. Photograph of Kettle Generating Station, 1973.

Following announcement of the program for development of the hydroelectric potential of the Nelson River, the governments of Manitoba and Canada considered the overall interest and possible conflict related to the use of the water resource. Subsequently, acting upon the advice of the Canada-Manitoba Advisory Committee on Water, established under the Canada Water Act 1970, the governments of Canada and Manitoba entered into an agreement to undertake studies to determine the effects of the regulation of Lake Winnipeg and diversion of flows from the Churchill River on the environment, resources, and communities.

# FOOTNOTES

[2-1] G.E. Crippen and Associates Limited. "Report on Lake Winnipeg Regulation", January, 1970.

[2-2] Underwood McLellan and Associates Limited. "Churchill River Diversion Study of Alternative Diversions", March, 1970.

[2-3] Manitoba Hydro Task Force. "Report on Expansion of Generating Capacity in Manitoba", October, 1970.

# chapter 3

# lake winnipeg, churchill and nelson rivers study

## INTRODUCTION

In August, 1971, an agreement was entered into between the government of Manitoba, represented by the Minister of Mines, Resources and Environmental Management, and the government of Canada, represented by the Minister of the Environment, to undertake a joint study of the effects of regulation of Lake Winnipeg, diversion from the Churchill River, and of development of the hydroelectric potential of the Churchill River Diversion Route. The federal and provincial governments recognized that the Nelson River hydroelectric development program was a single purpose use of the water resources of the Churchill and the Nelson rivers. Both governments were concerned that this program achieve the greatest overall benefit possible without unduly prejudicing the present or potential development of these water bodies for other resource uses and users.

The terms and conditions of the Agreement for the Lake Winnipeg, Churchill and Nelson Rivers Study specified the objectives, described the financial arrangements, established the terms of reference and guidelines, and authorized the administrative framework for the Study. A copy of the Agreement is reproduced as Annex A to this report.

## OBJECTIVE

The objective of the Study as stated in the Agreement was two-fold: to investigate and report on the effects of the works that will regulate Lake Winnipeg, divert flows from the Churchill River, and develop the hydroelectric potential of the Burntwood River on other water and related resource uses; and, to recommend to the federal and provincial governments, measures for enhancing the overall benefits and for mitigating undesirable effects of the hydroelectric projects.

## ORGANIZATIONAL FRAMEWORK

The ministers responsible for the Study were the Minister of Mines, Resources and Environmental Management, and the Minister of the Environment. As specified in the Agreement, the Lake Winnipeg, Churchill and Nelson Rivers Study Board was established to direct the Study (Fig. 3-1).

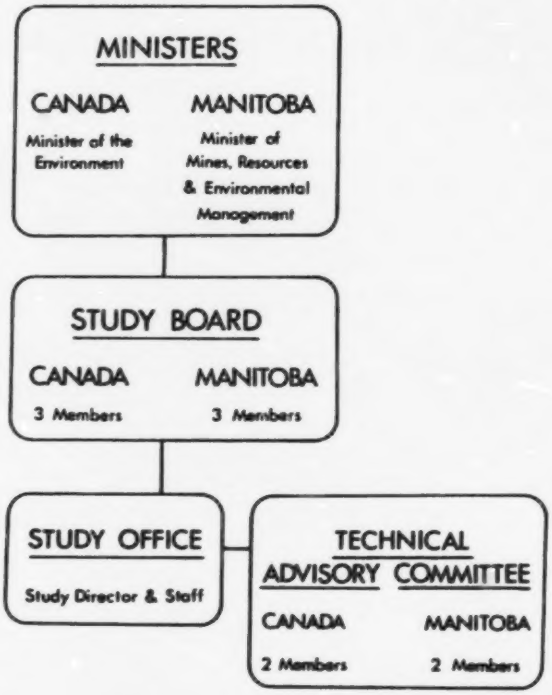

MINISTERS
CANADA
Minister of the Environment
MANITOBA
Minister of Mines, Resources & Environmental Management
STUDY BOARD
CANADA
3 Members
MANITOBA
3 Members
STUDY OFFICE
Study Director & Staff
TECHNICAL ADVISORY COMMITTEE
CANADA
2 Members
MANITOBA
2 Members

Fig. 3-1 Organizational Framework of the Lake Winnipeg, Churchill and Nelson Rivers Study.

The Board consisted of six members of whom three were appointed by Canada and three by Manitoba. The Board was responsible for the Study, met as required, and reported directly to the ministers. Chairmanship of the Board rotated on an annual basis between federal and provincial members as chosen by them. The first chairman was a provincial member.

The Board recommended the appointment of a full-time Study Director to the Manitoba Department of Mines, Resources and Environmental Management and the establishment of an office in Winnipeg. A Technical Advisory Committee of two members was appointed by each government to assist the Study Director. The Manitoba Department of Mines, Resources and Environmental Management managed the Study.

The ministers responsible, members of the Study Board, members of the Technical Advisory Committee and Study Office staff are listed in Annex B.

## FINANCIAL ARRANGEMENTS

The federal and provincial governments shared the costs of the Study equally to a maximum of $1,000,000 each. Under the Study Agreement, Manitoba was to assume responsibility for funding the Agreement and the financial arrangements were to be established by the Study Board. According to the Study Agreement the Manitoba Department of Mines, Resources and Environmental Management assumed responsibility for funding the Agreement and periodically submitted claims to the federal government for reimbursement. The provincial government kept complete records of all expenditures. These records were audited annually by the Provincial Auditor's Office and in the summer of 1974 all claims to date were examined by the Auditor General's Office. A final audit is to be made upon completion of the Study.

## LIMITATIONS OF THE STUDY

The announced hydroelectric projects were a precondition of the Study Agreement. The preamble of the Agreement refers specifically to the fact that Lake Winnipeg would be regulated, and the Churchill River would be diverted at Southern Indian Lake up to a maximum of 30,000 cubic feet per second (cfs), and that Southern Indian Lake would not be raised above elevation 850 ft. In outlining the program of studies dealing with water levels and flows, the Agreement states,

> *Certain information will be taken as given, namely that Lake Winnipeg will be regulated between the levels 711 and 715 feet elevation and that Southern Indian Lake will be raised to not more than 850 feet elevation for a diversion out of the Churchill River of up to 30,000 cubic feet per second.*

Accordingly, all investigations carried out on behalf of the Board were based on the fact that the announced hydroelectric projects had been initiated and would be constructed to the above specifications. The effects of the hydroelectric projects were predicted by comparing the differences between the conditions that would occur with the projects and the conditions that would occur without the projects. Tangible and intangible effects were examined in the construction phase and the operation phase in both the short-term and long-term.

## STUDY GUIDELINES

The Agreement stipulated that the study of the probable effects of the hydroelectric developments was to be sufficiently broad so as to include all important effects on the water regime and on related resource uses. The study program outlined in the Agreement divided the Study into three major sections and identified the investigations which were to be included in each of these sections. The three major sections were the effects on the water regime, the effects on the uses of water and related resources, and the social implications.

In general, priority was to be given to studies which could lead to recommendations for modifications or additions to the works, or operation of the works under construction. Attention was also to be given to the collection of baseline data to serve as reference points against which to measure future change. Studies which would establish and measure the present conditions of lakes and rivers to be affected by the hydroelectric projects within the study area were to be completed as soon as possible.

# CONDUCTING THE STUDY

The program of studies outlined in the Agreement was amplified at a seminar held by the Study Board in November, 1971. Senior federal and provincial employees, university faculty members, and private consultants reviewed and made suggestions regarding the implementation of the study program. Project descriptions, water level and flow data and resource data and information requirements were outlined, and available sources were identified. Subsequently, a series of seminars were held to identify the socioeconomic investigations which should be undertaken.

A Study Office was established in Winnipeg. Staff were employed to implement the study program.

During 1972, and to a lesser extent in 1973, implementation focused on awarding and administration of contracts. The Study Director asked federal and provincial government agencies, university faculty members, and private consultants to submit proposals for specific investigations. The costs, timing and methodologies outlined in the proposals were reviewed and approved by the Director and Technical Advisory Committee. On the basis of their appraisals, the Board allocated funds for individual studies and recommended that the Manitoba Department of Mines, Resources and Environmental Management authorize contracts for these studies.

The Study Office staff undertook co-ordination of the study program and field surveys. Seminars and workshops were arranged at which the contracting agencies reported on progress in their investigations and research, and identified data available to other study participants. A field co-ordinator was stationed in Thompson, Manitoba, during the summer field seasons of 1972 and 1973 to provide assistance in transportation and supply arrangements for survey groups. In 1974, a more limited field program was undertaken and contracting agencies generally made their own arrangements with some assistance from the Study Office.

The investigations by contracting agencies were conducted over a two-year period between spring, 1972, and summer, 1974. The Study Office was responsible for integrating the information provided by contractors in working documents. The major part of this work was performed in 1974 when the working documents were collated and integrated, and revised in those instances where supplementary data had become available. During the course of the Study, special issues and concerns arose which required the integration of material and special arrangements for reporting. The Study Office also acted as an intermediary in facilitating the exchange of field survey data and other information between contracting agencies.

during the course of their investigations.

## STUDY AREAS

The Study Office divided the area to be affected by the hydroelectric development into six geographic areas each to be investigated as a unit: Lake Winnipeg; Outlet Lakes; Diversion Route (Rat-Burntwood rivers); Southern Indian Lake; lower Churchill River; and lower Nelson River (Fig. 3-2). The purpose of this delineation into specific study areas was to facilitate implementation of priorities; administration of contracts; execution of investigations; and co-ordination and integration of the various studies. The division into six designated geographic areas has been employed in this report to describe and analyse the effects of regulation of Lake Winnipeg and diversion of flows from the Churchill River.

Priority for completion of studies in the first year of the program was placed on the Outlet Lakes. Construction of works associated with regulation of Lake Winnipeg had begun and it was essential that baseline data be collected before any change in the environment occurred.

### AREA 1 - LAKE WINNIPEG

Lake Winnipeg, the largest of Manitoba's lakes, is one of the major vestiges of ancient Lake Agassiz, a vast body of water left by the retreating glaciers of the ice age. The enormous drainage basin of Lake Winnipeg encompasses an area of some 380,000 square miles, extending west to east from the foothills of the Canadian Rockies to near the western shores of Lake Superior, south to the divide at the headwaters of the Missouri and Mississippi rivers in the northern United States, and as far north as the southern limit of the Churchill River watershed. The river systems of the Red, Winnipeg and Saskatchewan rivers all drain into Lake Winnipeg, together with numerous minor tributaries.

All the waters draining into Lake Winnipeg flow out of the lake at its northern end into the Nelson River through the only outlet at Warren Landing. At this point the Nelson River begins its 410-mile course to Hudson Bay, descending some 713 ft. By virtue of its enourmous surface area of 9430 square miles, Lake Winnipeg acts as an efficient natural regulating reservoir, with the result that fluctuations between high and low flows in the Nelson River are relatively small.

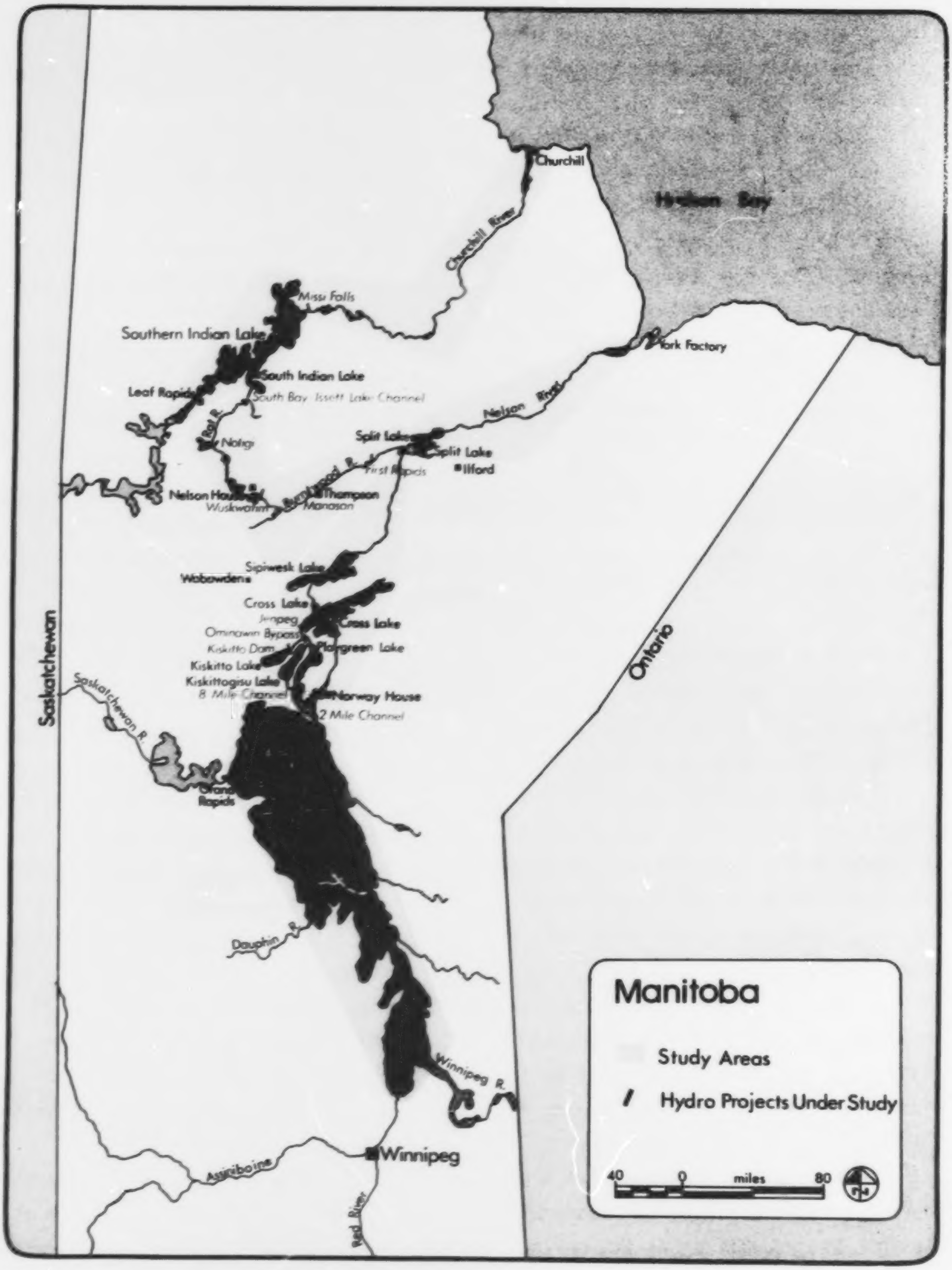

Hudson Bay
Churchill
Churchill River
Missi Falls
Southern Indian Lake
South Indian Lake
Leaf Rapids
South Bay Issett Lake Channel
Rat R.
Notigi
Nelson River
York Factory
Split Lake
Split Lake
First Rapids
Ilford
Nelson House
Wuskwatim
Burntwood R.
Thompson
Manasan
Sipiwesk Lake
Wabowden
Cross Lake
Jenpeg
Cross Lake
Ominawin Bypass
Kiskitto Dam
Playgreen Lake
Kiskitto Lake
Kiskittogisu Lake
8 Mile Channel
Norway House
2 Mile Channel
Saskatchewan
Saskatchewan R.
Grand Rapids
Ontario
Dauphin R.
Winnipeg R.
Winnipeg
Assiniboine
Red River
Manitoba
Study Areas
Hydro Projects Under Study
40
0
miles
80

Fig. 3-2. Location of Study Areas.

## AREA 2 - OUTLET LAKES

The Outlet Lakes area is that portion of the Nelson River between Warren Landing and Cross Lake. Over a distance of approximately 70 miles it consists of a complex system of shallow lakes and divided channels which exercises a natural control on discharges from Lake Winnipeg. From Warren Landing, the Nelson River flows into Playgreen Lake, a wide, shallow, rock-studded expanse of water. Here the river divides into two main channels, approximately 15 to 20 percent of the flow finding its way through Little Playgreen Lake and the narrow East Channel to Cross Lake, while the main flow is from the northern end of Playgreen Lake through Whiskey Jack Narrows into Kiskittogisu Lake. This latter lake has three outlet channels, Kisipachewuk, Metchanais and Ominawin Rapids, all of which discharge via the West Channel into Cross Lake.

## AREA 3 - DIVERSION ROUTE (RAT-BURNTWOOD RIVERS)

The Rat-Burntwood rivers are characteristically sluggish streams interspersed with rapids and falls. These rapids and falls occur where the streams cross bedrock highs and, at most of them, the channel is flanked by low rock outcrop ridges.

The main stem of the Burntwood River flows out of Burntwood Lake at the Churchill basin divide, and continues in a generally easterly direction for some 50 miles. It then turns abruptly north and after approximately 15 miles enters Threepoint Lake. The fall in this upper portion totals 130 ft from elevation 915 ft at Burntwood Lake to elevation 785 ft at Threepoint Lake.

The Rat River, the major tributary of the Burntwood, also flows into Threepoint Lake. It has its source at the Churchill basin divide to the south of Southern Indian Lake and east of Granville Lake. From its swampy headwaters at an elevation of 810 ft to 830 ft, it flows east and south by turns through a chain of lakes and sluggish channels separated by short stretches of rapids, to join the Burntwood at Threepoint Lake.

Below Threepoint Lake the Burntwood River flows generally eastward for 30 miles to Birch Tree Lake west of Thompson. In this stretch the channel is regular with clay and silt banks, and flow is sluggish. At intervals these characteristics are interrupted by falls or rapids, and at two points by the enlargements of Wuskwatim and Opegano lakes.

At Birch Tree Lake, with an elevation of 625 ft, the Burntwood turns abruptly northeast and maintains this general direction for some 60 miles to its mouth at Split Lake, elevation 545 ft, on the Nelson River. This portion of the river is similar in character to that above Birch Tree Lake except that the channel is generally broader and the banks somewhat higher.

## AREA 4 - SOUTHERN INDIAN LAKE

Southern Indian Lake, a broadening of the Churchill River, is 85 miles long and has a surface area of 734 square miles. Rivers flowing into Southern Indian Lake include the Churchill River, Barrington River, Muskwesi River and the Waddie River. The Churchill River is the only river draining the lake. The area lies within the Canadian shield physiographic region and was glaciated during the Pleistocene epoch and most current landforms resulted from erosion or deposition by glaciers.

## AREA 5 - LOWER CHURCHILL RIVER

The Churchill River drains 115,000 square miles in Alberta, Saskatchewan and Manitoba. The drainage area in Manitoba covers 38,000 square miles. The long-term mean flow of the Churchill River at the outlet of Southern Indian Lake is 35,700 cubic feet per second (cfs) and 40,000 cfs when it enters Hudson Bay at Churchill, Manitoba. The lower Churchill River drops over several rapids from an elevation of 840 ft to sea level at Hudson Bay. The river widens into several lakes from Missi Falls to Hudson Bay; these are Partridge Breast, Northern Indian, Fidler, and Billard lakes. Total surface area of these lakes is approximately 100 square miles.

## AREA 6 - LOWER NELSON RIVER

The lower Nelson River includes Split Lake and all waters downstream to Hudson Bay. Split Lake, a widening of the Nelson River at its confluence with the Burntwood, is a depression in rugged, bedrock-controlled topography. The river from Split Lake to Kettle Rapids flows through the Precambrian shield in an irregular channel. A short distance downstream, at Long Spruce Rapids, limestone replaces granitic rocks as riverbed material. The highest banks on the river are found in this section. The flow is fast throughout the steep gradient. Below Limestone Rapids the river again rides the surface of the bedrock as the gradient lessens. Below Kettle Rapids ice accumulation has been a major factor in forming the riverbanks. Stretching to 50 ft above the water is a zone of ice-scoured vegetation.

# STUDY PROGRAM

The components of the study program as identified in the Agreement and modified at subsequent seminars, were further elaborated by the Study Office. The investigations that were authorized by the Study Board were within the six designated geographic areas. A list showing the study area, the title of the working documents submitted following completion of investigations, and the reporting agency, is provided in Annex C.

The agencies under contract to the Study Board represented a number of areas of specialization in the engineering, biological, and social science disciplines. Their working documents, utilizing the results of comprehensive field investigations and surveys over a two-year period of study, formed the basis for the findings and recommendations in this report. These working documents are reproduced in the appendices of this report.

Contracts for most investigations had been awarded by spring, 1972. However, four studies which were initiated prior to the signing of the Study Agreement were incorporated into the study program. These studies comprised mapping of the shoreline of the south basin of Lake Winnipeg, Lake Winnipeg shoreline erosion and sand movement study, Lake Winnipeg and northern Manitoba recreation study, and archaeological studies along the Churchill River Diversion Route.

Difficulties in finding a qualified agency to undertake the wildlife investigations delayed awarding of the contract until fall, 1972. Contracts for the first phase of the physical impact and of the socioeconomic studies were awarded in 1972 to private contractors. The second phase of these studies was completed by study teams formed within the Manitoba Department of Mines, Resources and Environmental Management.

As the studies progressed, it became evident that a comprehensive study of the effects of the diversion from the Churchill River on the ice regime in the lower Churchill River was required. Manitoba Hydro had already initiated ice studies on Cross Lake and the Rat-Burntwood rivers, and agreed to supply the Board with this information. A contract for an ice regime study of the lower Churchill River was awarded in fall, 1973.

# REPORTING RESULTS

The Agreement provided for recommendations to be submitted by the Study Board to the ministers and to Manitoba Hydro whenever studies revealed information relevant to the design or construction of the hydroelectric works. Recommendations were submitted annually in progress reports. The Board's progress reports in 1972 and 1973 recommended to the ministers and to Manitoba Hydro, that specific actions be undertaken prior to the completion of the hydroelectric projects, to mitigate undesirable effects and to enhance overall benefits of the projects. The three progress reports are appended to this report and are also available on loan from the Manitoba Provincial Library. Recommendations were also made on a number of special issues and concerns which arose during the course of the Study.

## SPECIAL ISSUES

The special issues and concerns that arose as various investigations proceeded included: timber clearing; the regulation of Kiskitto Lake; establishment of a long-term ecological monitoring program; possible detrimental effects on Churchill's water supply system; possible detrimental effects on wildlife and transportation in the Churchill River estuary; and the revised scheduling of the short-term operation of the Churchill River diversion works. As information on some of these issues became available during the course of the Study, the Board, where considered necessary, recommended appropriate action to the ministers and Manitoba Hydro by special communication.

Manitoba Hydro was undertaking a limited timber clearing program for some of the forested land that will be inundated upon completion of the hydroelectric projects, and requested that the Board recommend which areas should be cleared. Initially, a report was prepared which outlined general guidelines and practices to be followed in clearing. This was forwarded to the ministers and to the Chairman of Manitoba Hydro for implementation. In addition, three working documents were prepared by the Study Office which summarized and integrated the information on all the sites that had been recommended by study contractors for pre-flood clearing. The documents on Southern Indian Lake and the Churchill River Diversion Route were forwarded to the Manitoba Department of Mines, Resources and Environmental Management and formed the basis for the departmental clearing guidelines which were transmitted to Manitoba Hydro for implementation.

Manitoba Hydro also asked the Board to study the design plans for the regulation works on Kiskitto Lake and to make recommendations on modifications of the design and operating conditions. A report entitled, "Impact Analysis of Kiskitto Lake Regulation", was prepared by the Study Office based on an assessment made by agencies under contract to the Study Board. It was recommended that a stoplog structure be constructed and that the lake be managed to further enhance project benefits in the area particularly those related to wildlife. The Study Board forwarded this report to the ministers and the chairman of Manitoba Hydro in October,1973. The stoplog structure has been completed and the Canadian Wildlife Service, Canada Department of the Environment, is currently developing a wildlife management program for the lake.

At an early stage of the Study, it became evident that a long-term ecological monitoring program of the study area was required to assess and monitor long-term environmental changes attributed to artificial manipulation of water levels and flows. The Study Board, in January, 1974, submitted a report entitled, "Long Term Ecological Monitoring of the Lake Winnipeg, Churchill, Nelson Rivers Impact Areas" to the ministers and the chairman of Manitoba Hydro. The Board recommended that the study requirements as outlined in the report be forwarded to the Canada-Manitoba Advisory Committee on Water.

In its third progress report the Board recommended that Manitoba Hydro take the necessary action to protect the town of Churchill's water supply facilities from salt water intrusion and from ice damage. Manitoba Hydro has initiated a study into alternative methods of protecting these water supply facilities. Subsequently, the Board, in a communication to the ministers and to the Chairman of Manitoba Hydro, drew attention to possible additional detrimental effects which were identified in its studies of the Churchill River diversion project. These detrimental effects concerned wildlife in the Churchill River estuary, and transportation on the Churchill River from the estuary to the junction of the Churchill River and Deer River. The Board recommended that the information on these impacts and the suggested possible courses of action be forwarded to the appropriate government agencies so that continuing programs could be reviewed and modified, and new programs initiated.

In November, 1974, the Board reported to the ministers that information had become available that it was unlikely that the Churchill River Diversion project would need to be operated in full design capacity until November, 1976. The Board recommended that appropriate government agencies be made aware of the possibility of a one-year delay in the schedule for the operation of the Churchill River diversion works.

Early in 1974 as the results of investigations were becoming available it became evident that government agencies, whose responsibility included establishing and implementing development programs in northern Manitoba, should have access to these results in order to modify their programs where necessary. This process was facilitated by the establishment of Study Auditors. The Study Auditors were appointed by the provincial and federal governments. Provincial members represented the Department of Mines, Resources and Environmental Management and the Department of Northern Affairs, and federal members represented the Department of Indian Affairs and Northern Development. The Study Auditors procured current information on study findings from the Study Office.

The Board also met with the Northern Flood Committee which represents the local communities that will be affected by the hydroelectric projects. Subsequently, the Board supplied copies of all the working documents prepared by authorized agencies to the legal representatives of this Committee.

The Study has served to provide baseline data and experience in planning and conducting future resource management studies. The baseline information generated by the Study can serve as an aid in determining fair compensation and proper mitigation for resource uses that may be adversely affected as a result of the Manitoba Hydro projects. Availability of these data will also permit pre-project and post-project appraisals which can be used to obtain the most benefit from resources that will be affected by the hydroelectric projects.

In the wider context of the issues and problems associated with the development of northern regions, the data collected and related information made available by the Study should prove of assistance to decision-makers, in both the public and private sectors, in formulating programs and projects for the further development of the economy of northern Manitoba.

# chapter 4

# lake winnipeg regulation and churchill river diversion projects

## INTRODUCTION

In Chapter 3 a description was provided of the process whereby the Study Board implemented the intergovernmental Agreement and directed the study of the effects of the regulation of Lake Winnipeg, the diversion from the Churchill River, and the development of the hydroelectric potential of the Diversion Route. Under the terms of the Study Agreement,

> *Canada and Manitoba agree*(d) *to give priority to those studies which may lead to recommendations for modifications or additions to the works, or operation of the works, that may be under construction, approved or proposed.*

The present chapter provides a description of the function, the project works, and the operating conditions of these three components of the Nelson River hydroelectric development program.

# LAKE WINNIPEG REGULATION

The works under construction for Lake Winnipeg will increase the lake's discharge capacity and will regulate the flows from the lake to the Nelson River so as to coincide with the winter peak period of Manitoba's electrical energy demands. Under unregulated conditions, rates of outflow from Lake Winnipeg have seasonal variations which do not coincide with power demands. When discharges are high in July, power demand in Manitoba is low, and conversely when discharges are low in late December, power demand is at its peak. One purpose, therefore, of the Lake Winnipeg regulation project is to ensure that releases from the lake can be increased during the winter months. In addition, the project will permit some storage on the lake to stabilize outflows over periods of several years.

Three new channels which will substantially increase the winter discharges from the lake, thereby greatly increasing power generation at Nelson River generating stations, are being excavated in the Outlet Lakes area. In addition, the flow capacity of Kisipachewuk Channel is being improved. To coincide with peak energy demands the pattern of discharges from Lake Winnipeg and the Outlet Lakes will be controlled by means of the Jenpeg control structure on the West Channel of the Nelson River at its point of entry into Cross Lake.

Fig. 4-1 indicates the major works under construction to regulate Lake Winnipeg.

The three channels being excavated are 2-Mile Channel, 8-Mile Channel, and Ominawin Bypass Channel.

2-MILE CHANNEL - When completed in late 1975, this channel will connect Lake Winnipeg and Playgreen Lake. It is designed to supplement the natural channel at Warren Landing and will increase the discharge capacity between Lake Winnipeg and Playgreen Lake. Excavation by a hydraulic suction dredge began in late 1974 and the channel is expected to be operational by fall, 1975. It will be approximately 425 ft wide and 25 ft deep.

8-MILE CHANNEL - This channel which connects Kiskittogisu Lake and Playgreen Lake will be operational in June, 1975 (expected completion - fall, 1975). This channel is designed to supplement the discharges through Playgreen Lake Narrows and Whiskey Jack Narrows and will increase the discharge capacity between Kiskittogisu Lake and Playgreen Lake. The channel bottom varies in width from

425 ft to 1000 ft and is being excavated by a hydraulic suction dredge (Fig. 4-2)

OMINAWIN BYPASS CHANNEL - Connecting the natural Ominawin Channel and the West Channel of the Nelson River, the Ominawin Bypass Channel enables the diversion of some flow south of Ominawin Rapids. To be completed in June, 1975, this channel supplements the conveyance capacity of Ominawin Channel. It is approximately two miles long, 1100 ft wide and 25 ft deep. Most of the excavation was carried out in the dry; however, a small dredge was used on the upstream entrance to the

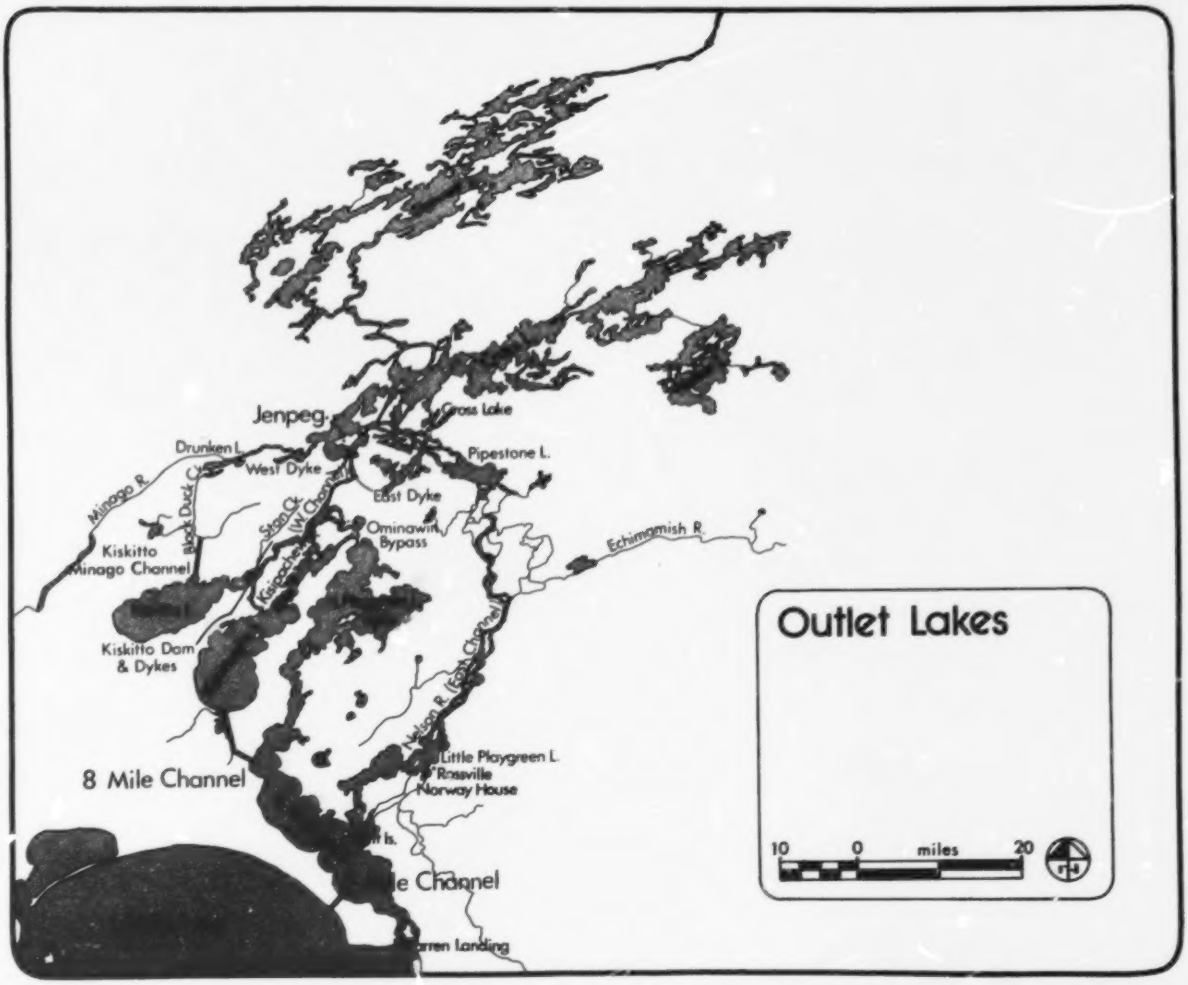

Outlet Lakes
Jenpeg
Cross Lake
Drunken L.
West Dyke
Pipestone L.
Minago R.
Black Duck Cr.
Stan Ck.
(W. Channel)
East Dyke
Ominawin Bypass
Echimamish R.
Kiskitto Minago Channel
Kisipachee
Kiskitto Dam & Dykes
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
8 Mile Channel
Is.
le Channel
rren Landing
10
0
miles
20

Fig. 4-1. Location of the Major Works to Regulate Flows from Lake Winnipeg

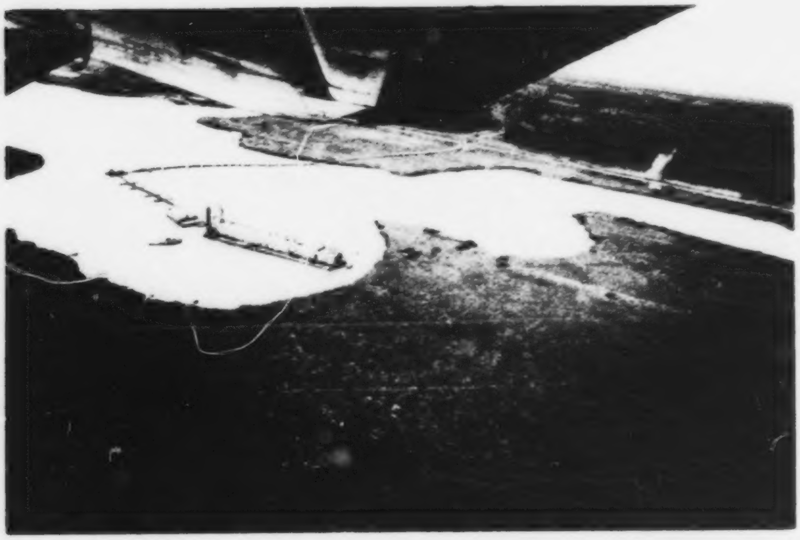


Fig. 4-2. Photograph of a Hydraulic Dredge in Operation at 8-Mile Channel, 1972.

bypass channel. Ice pans resulting from broken ice cover could form ice jams which would reduce the discharge capacity of the river system. This would be contrary to the objective of the project which is to supplement the discharge capacity of Ominawin Channel. To facilitate the formation of a smooth ice cover there is a rock groin along the centre line of the channel.

KISIPACHEWUK RAPIDS - In summer, 1973, Kisipachewuk Rapids were excavated to remove a rock ledge that restricted flow. A channel approximately 200 ft wide and 8 ft deep was formed by removing an estimated 10,000 cubic yards of rock.

JENPEG CONTROL STRUCTURE - Located on the West Channel of the Nelson River, this structure will regulate the pattern of discharges from Lake Winnipeg and the Outlet Lakes (Fig. 4-3). The structure will control approximately 80 percent of the average Lake Winnipeg discharge [70,000 cubic feet per second (cfs)]. The remaining flow passes down the uncontrolled East Channel which discharges into Pipestone Lake, an integral part of Cross Lake, thereby bypassing the Jenpeg control facility. The structure consists of a spillway, a powerhouse and a dam (Fig. 4-4). The spillway was completed in summer, 1974, and is operational. Construction has begun on the dam which is scheduled for completion in fall, 1975. The dam will permanently close the natural outlet of the West Channel and divert flows through the spillway and powerhouse. While the primary purpose of Jenpeg is to control the pattern of discharges from Lake Winnipeg, generating facilities are being installed. The first generating unit will be operational by July, 1976, and the sixth unit by May, 1977. The station, when fully installed, will generate 168,000 kilowatts by using a head of approximately 25 ft.

A system of small dams and dykes has been constructed in the vicinity of Jenpeg to ensure hydraulic control. To contain the Jenpeg forebay, a dyke on the east bank and three dykes on the west bank of the West Channel have been constructed.

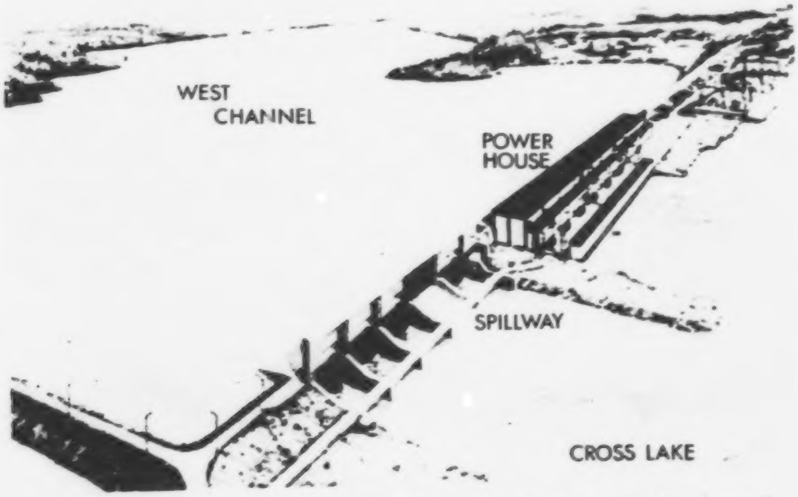


Fig. 4-3. Artist's Conception of Jenpeg Control and Generating Station When Completed

KISKITTO LAKE - A dam was constructed in November, 1973, to isolate Kiskitto Lake from the West Channel of the Nelson River. A gated culvert has been installed in the dam to permit inflows from the West Channel as required. The natural drainage into Kiskitto Lake is being discharged into the Minago River via Black Duck Creek and is regulated by a small control structure which was completed in March, 1974. The added discharge into Black Duck Creek could raise the water level in that creek by as much as 2 ft. In addition, because a dyke was required at the mouth of Stan Creek to contain the Jenpeg forebay, flow from this creek is being diverted into Kiskitto Lake. Isolation of this lake will ensure hydraulic control of the West Channel. Regulation of Kiskitto Lake will facilitate its management for wildlife and recreation.

Fig. 4-4. Photograph of Jenpeg Control and Generating Station Under Construction, Summer, 1974

EAST CHANNEL CONTROL STRUCTURE - A control structure was proposed at Sea River Falls on the East Channel as a means to regulate flows through this channel. Lake Winnipeg flows into Cross Lake via the West and East channels of the Nelson River, and power production at Jenpeg (on the West Channel) could be increased by controlling discharges through the East Channel. Studies on this proposal have indicated that the increase in power production at Jenpeg would not justify the cost of building the structure and, therefore, it is doubtful that this project will be pursued.

# CHURCHILL RIVER DIVERSION

The Churchill River diversion project will divert water from the Churchill River at Southern Indian Lake to augment the flows of the Nelson River. It is estimated that it will increase generation from power plants along the lower Nelson River by approximately 30 percent. The major construction works associated with this project (Fig. 4-5) are a control structure at Missi Falls, a diversion channel at South Bay on Southern Indian Lake and a control structure on the Rat River near Notigi Lake.

MISSI FALLS - The only outlet of the Churchill River from Southern Indian Lake is at Missi Falls. This outlet is formed by a north and south channel separated by Patterson Island (Fig. 4-6). A gated spillway and dam are being constructed at Missi Falls to control the discharges into the lower Churchill River and to regulate the lake level. Two cofferdams, A and B, have been placed across the south channel. With completion of the spillway in June, 1975, cofferdam B will be removed. Following this, the north channel will be closed and discharges of the Churchill River will be reduced. In accordance with the terms of the licence, a minimum discharge of 500 cfs in summer and 1500 cfs in winter is to be maintained at Missi Falls. The remainder of the Churchill River flow will be diverted into the Rat-Burntwood rivers system.

With completion of the north channel dam in fall, 1975, the level of Southern Indian Lake could be raised approximately 10 ft higher (elevation 847 ft) than the unregulated mean. A maximum drawdown or fluctuation of about 2 ft (elevation 847 ft to 845 ft) is anticipated during any twelve-month period. Average discharges at Missi Falls will be reduced by approximately 75 percent to allow for average diversion flows of about 27,000 cfs to the Nelson River.

SOUTH BAY - ISSETT LAKE DIVERSION CHANNEL - This channel will connect South Bay on Southern Indian Lake to Issett Lake at the headwaters of the Rat River (Fig. 4-7). It is being excavated through a natural rock dyke and a system of lakes and streams. The minimum bottom width of the channel is 200 ft, increasing up to 520 ft at the discharge end in Issett Lake. The depth of the channel varies from 23 ft to 32 ft. This 5.6-mile channel connects the Churchill River drainage basin with the Nelson River drainage basin and will enable the diversion of up to 30,000 cfs from the Churchill River to the Nelson River. Control through South

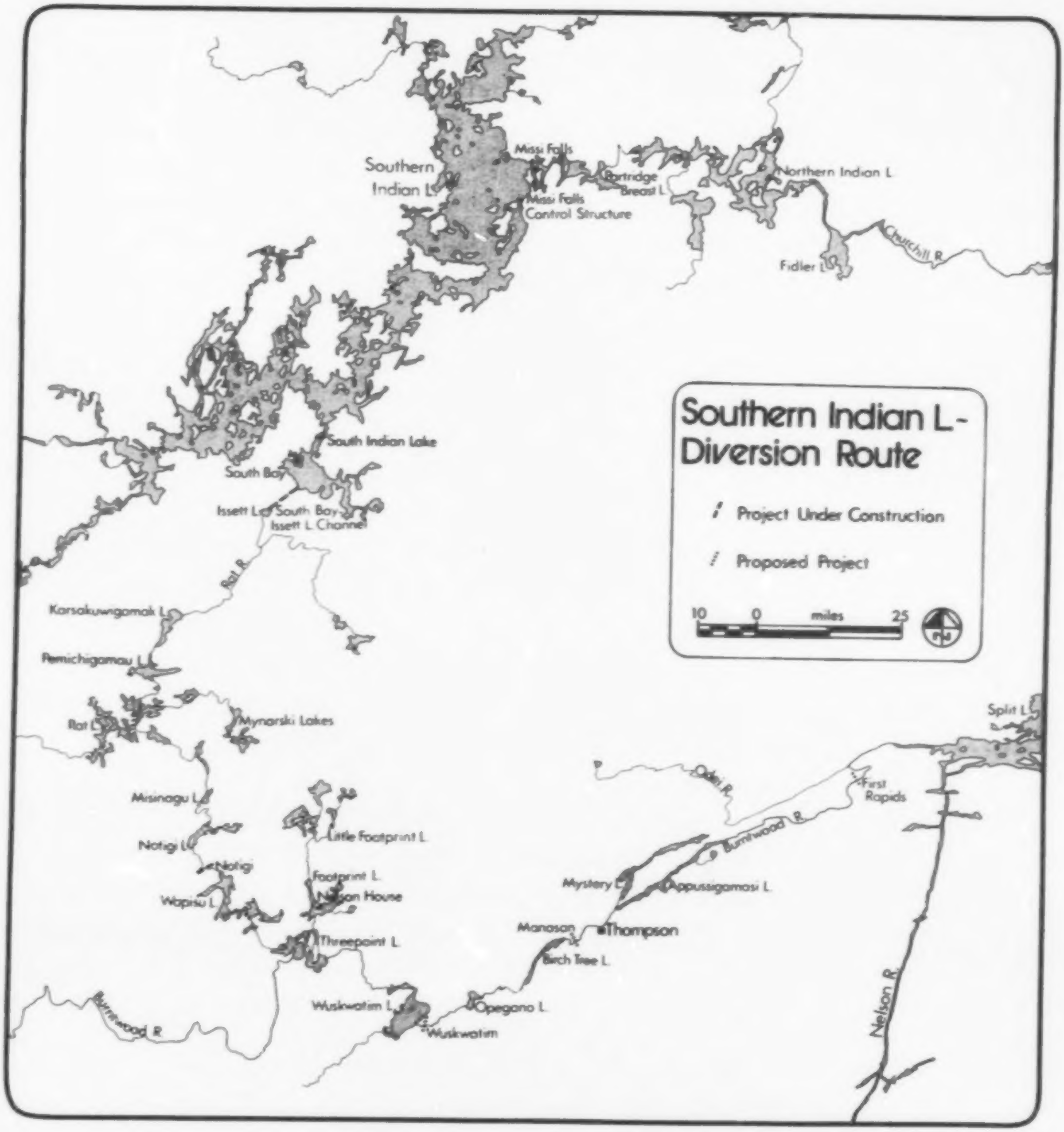

Southern Indian L
Missi Falls
Missi Falls Control Structure
Partridge Breast L
Northern Indian L
Churchill R
Fidler L
Southern Indian L-Diversion Route
Project Under Construction
Proposed Project
10
0
miles
25
South Indian Lake
South Bay
Issett L
South Bay-Issett L Channel
Rat R
Karsakuwigamak L
Pemichigamau L
Rat L
Mynarski Lakes
Misinagu L
Notigi L
Notigi
Wapisu L
Little Footprint L
Footprint L
Nelson House
Threepoint L
Wuskwatim L
Wuskwatim
Burntwood R
Opegano L
Birch Tree L
Manasan
Thompson
Mystery L
Apussigamasi L
Burntwood R
Odei R
First Rapids
Split L
Nelson R

Fig. 4-5. Location of the Major Works to Divert Flows From the Churchill River and of Future Generating Sites.

Bay Channel is scheduled to be effected in November, 1975.

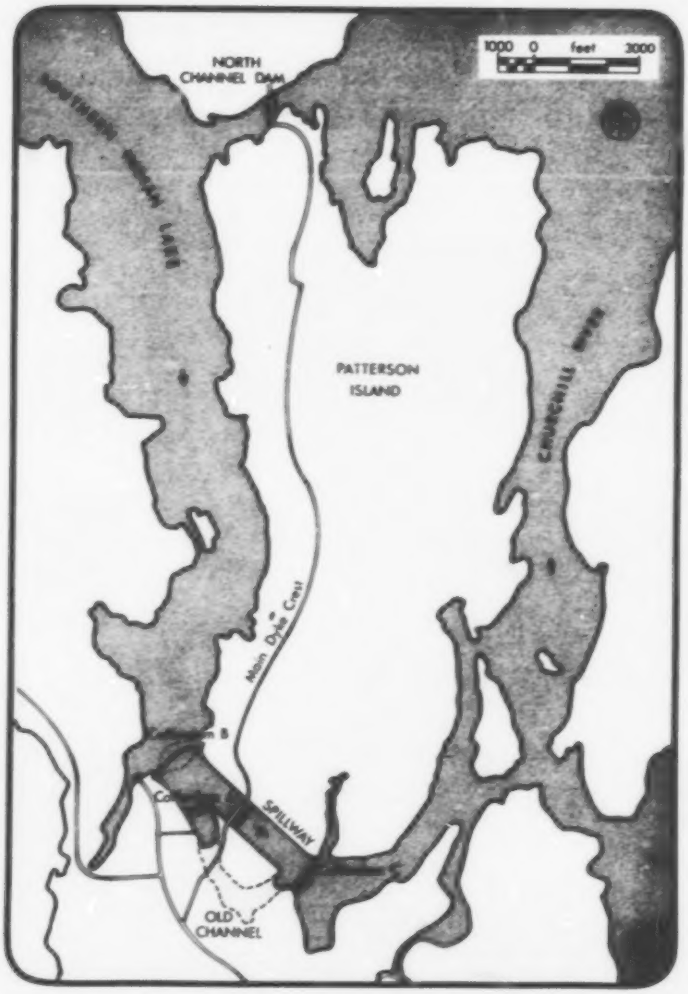

1000 0 feet 3000
NORTH CHANNEL DAM
SOUTHERN INDIAN LAKE
PATTERSON ISLAND
CHURCHILL RIVER
Main Dyke Crest
SPILLWAY
OLD CHANNEL

Fig. 4-6. Location Plan of Missi Falls Control Structure

NOTIGI CONTROL STRUCTURE - Under construction on the Rat River approximately 6 miles south of Notigi Lake, this structure will control the diversion discharge in order to augment the flows of the Nelson River. It consists of an 800 ft dam and a 200 ft spillway (Fig. 4-8). In addition, Manitoba Hydro has made provision in the design for generating facilities and has tentatively scheduled installation of these facilities in the 1990's.

Historically, the average mean monthly discharge of the Rat River at Notigi

Lake has been 1165 cfs. Under the terms of the interim licence for Churchill River diversion, Manitoba Hydro is authorized to release an average weekly flow of not more than 30,000 cfs through the Notigi control structure. Manitoba Hydro is required to vary the magnitude of release through the Notigi control structure to ensure that the flow in the Burntwood River at Thompson does not exceed the historic average mean flow (3500 cfs) plus the maximum permissible diversion flow of 30,000 cfs.

Fig. 4-7. Photograph of the Area That Has Been Cleared For the Excavation of the South Bay to Issett Lake Diversion Channel, Summer, 1973.

WUSKWATIM, MANASAN FALLS AND FIRST RAPIDS - These three sites along the Rat-Burntwood rivers system have been proposed for developing the hydroelectric potential of the Diversion Route (Fig. 4-5). Construction of generating facilities at these locations has been tentatively scheduled for the 1990's. The combined electrical output capacity of these stations has been estimated to be 640,000 kilowatts. While planning and design of these structures are incomplete, Manitoba Hydro's preliminary calculations (based only on energy production values) indicate optimum forebay levels of elevation 800 ft for Wuskwatim, 690 ft for Manasan, and 610 ft for First Rapids. These forebay levels, however, could be as much as 10 ft higher or lower.

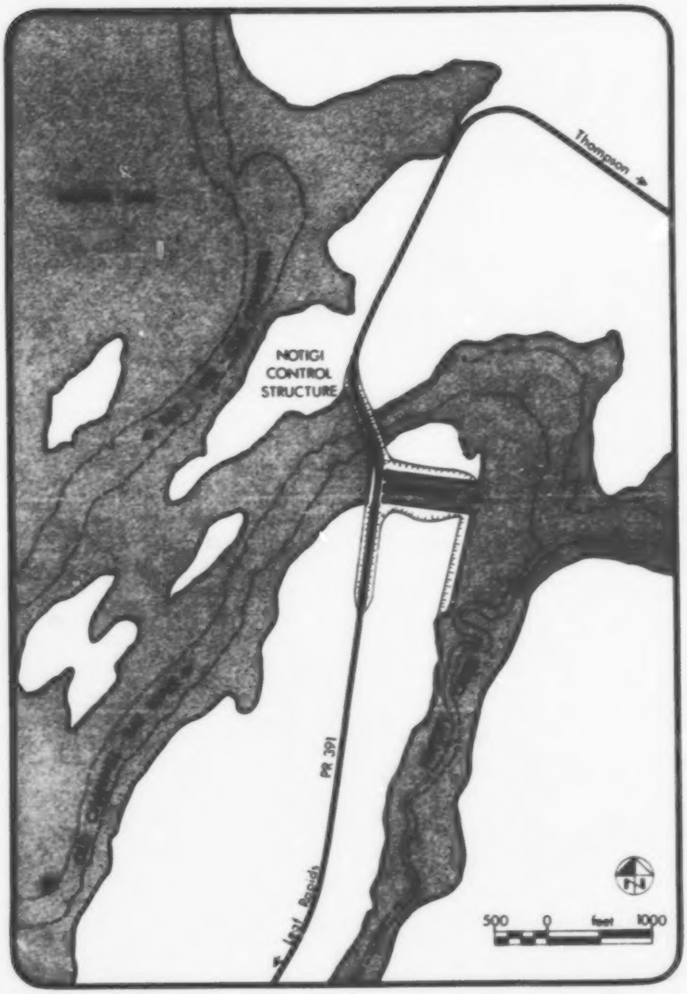

NOTIGI CONTROL STRUCTURE
Thompson →
PR 391
← Leaf Rapids
500 0 feet 1000

Fig. 4-8. Location Plan of Notigi Control Structure.

# chapter 5

## area 1
## lake winnipeg

### GEOGRAPHY

#### LOCATION

Lake Winnipeg is located in the Manitoba lowlands lying between the Manitoba escarpment on the west and the Precambrian shield on the east. It is part of a water system which includes lakes Winnipegosis and Manitoba, and the Red, Winnipeg and Saskatchewan rivers.

Lake Winnipeg is the largest lake in Manitoba and the twelfth largest in the world. It has a surface area of 9430 square miles, which accounts for 23.6 percent of the province's total water area of 39,987 square miles. The lake, the shorelines, and major marshes along the shorelines, comprise the area which was investigated.

#### CLIMATE

The climate of the Lake Winnipeg area is characterized by long, cold winters and relatively short, cool summers. Lake Winnipeg and Lake Manitoba modify the climate of southern Manitoba. At the northern end of the lake, the average January temperature is -8°F and the average July temperature is 64°F. At the southern end of the lake, the average January temperature is -2°F and the average July temperature is 66°F. The frost free season varies from 100 to 120 days from the north to the south end of the lake.

Annual precipitation ranges from 20 inches at the southern end of the lake to less than 18 inches at the northern end. Annual snowfall increases from 55 inches in the north to 60 inches in the south. Summer rainfall (May, June, July) also increases from north to south with this form of precipitation averaging 5 inches at the northern end of the lake and 8 inches at the southern end.

## PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL

The shores of Lake Winnipeg lie within four physiographic divisions. The east shore of Lake Winnipeg falls within the transitional zone of the Precambrian shield. The west shore is within the Interlake-Westlake plain of the Manitoba lowlands. Approximately 60 miles along the southern tip are in the Red River plain, and the remaining 20 miles of shoreline at the extreme northern tip are in the Upper Nelson plain.

The southern shoreline is typical of the low lying Red River plain. Relief is flat to gently undulating and much of the area has less than 8 ft of relief. Lacustrine clay and alluvial deposits vary from a few feet to 60 ft in depth near the Red River. Large areas were swampy until recent drainage programs were implemented. The eastern shore is typical of low lying Precambrian shield areas. Relief is rolling to undulating. Clay deposits are restricted to stream courses and localized depressions. There are extensive areas of peat, swamp and muskeg overlying glacial drift and bedrock. Soils are podzolic and organic. The western shore has gentle relief with a shallow mantle of calcareous till. There are extensive areas where lacustrine clays are deposited over these tills.

The northern extreme of the area has undulating topography. Lacustrine clays with areas of bedrock outcrops and bog are common. The northern shore is flat to gently undulating and is characterized by lacustrine clay and alluvial deposits.

The geology of the Lake Winnipeg area is quite complex as Silurian, Ordovician and Precambrian formations are present. Generally, Silurian dolomites are present on the west side of the lake. Undivided Ordovician material (generally limestone) is also present in the northwest portion. Precambrian granites and gneisses are present on the east side. Ordovician limestone, dolomite, red shale and sandstone occur in the south.

## VEGETATION

Northern coniferous forests dominate the eastern and north-western portions of this area. The most common species on the poorly drained land is black spruce

(*Picea mariana*); however, tamarack (*Larix laricina*) is also common. White spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), white birch (*Betula papyrifera*), and balsam fir (*Abies balsamea*) occur in alluvial soils with better drainage near rivers. Jack pine (*Pinus banksiana*) occurs on well drained ridges. Dominant shrubs include alder (*Alnus* sp.), dwarf birch (*Betula glandulosum*) and willows (*Salix* spp.).

In the south-western and southern portions of the area the predominant forest is the mixed-wood type. Characteristic vegetation is white spruce, aspen and balsam poplar. An aspen-oak zone with burr oak (*Quercus macrocarpa*), balsam poplar and hazel (*Corylus* sp.) occurs in the extreme south-western portion near Winnipeg Beach.

## DRAINAGE PATTERN

The surface area of Lake Winnipeg at mean level is 9430 square miles. The total drainage area of rivers leading into the lake is 380,000 square miles (Fig. 5-1). The drainage system encompasses portions of Alberta, Saskatchewan, Manitoba, Ontario, North Dakota and Minnesota. The drainage basin stretches from the Rocky Mountains to near Lake Superior and south to the headwaters of the Mississipppi River.

The Winnipeg and Saskatchewan rivers contribute 71 percent of the inflow to Lake Winnipeg while the Poplar, Pigeon, Berens, Bloodvein, Manigotagan, Brokenhead, Dauphin, and Red rivers contribute the remaining 29 percent.

## HUMAN HABITATION

Investigations into the socioeconomic effects of the regulation of Lake Winnipeg on the communities on the lake were not undertaken. These communities are socially and economically very diverse and include: resort communities such as Victoria Beach, Grand Beach, and Winnipeg Beach; industrial communities such as Gimli and Pine Falls; remote native centres such as Bloodvein and Berens River; and small remote settlements serving primarily as fish collection stations such as Anama Bay (Fig. 5-2). Each category of communities is characterized by different social and economic conditions and each would require specific examination. In addition, the availability of transportation infrastructure and services varies from communities connected by all-weather roads such as Grand Rapids to communities on the east side of the lake whose only means of overland transportation is winter roads. The effects of the regulation of Lake Winnipeg on the physical environment, the resource base and resource utilization in the Lake Winnipeg area would have to be related to specific communities on the lake in order to predict the socioeconomic effects.

The effects of Lake Winnipeg regulation on structures located around the lake such as dykes, homes, cottages, docks and piers were examined. The results of these investigations on community infrastructure are presented in a subsequent section.

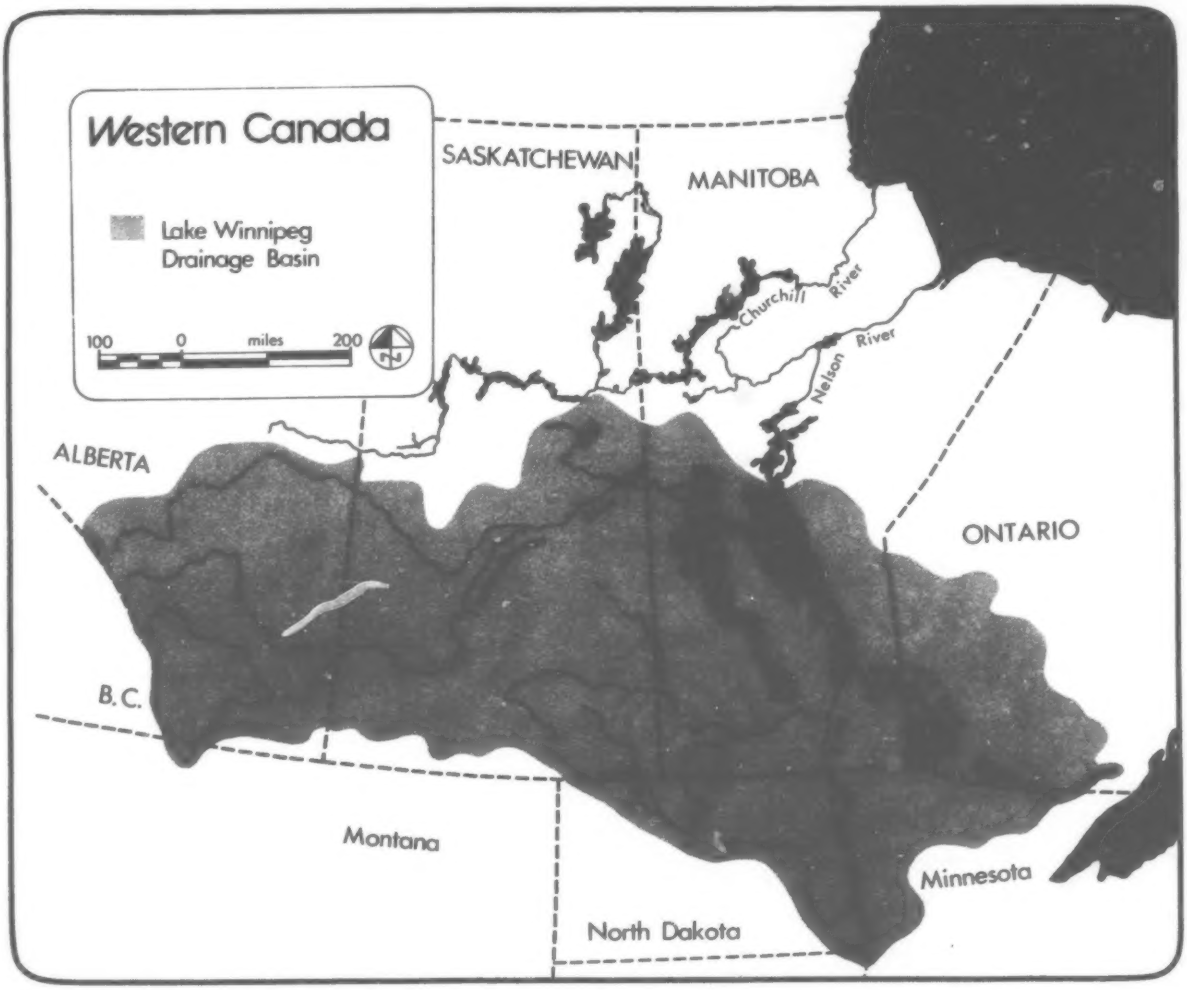

Western Canada
▨ Lake Winnipeg Drainage Basin
100
0
miles
200
SASKATCHEWAN
MANITOBA
Churchill River
Nelson River
ALBERTA
ONTARIO
B.C.
Montana
North Dakota
Minnesota

Fig. 5-1. Drainage Basin of Lake Winnipeg.

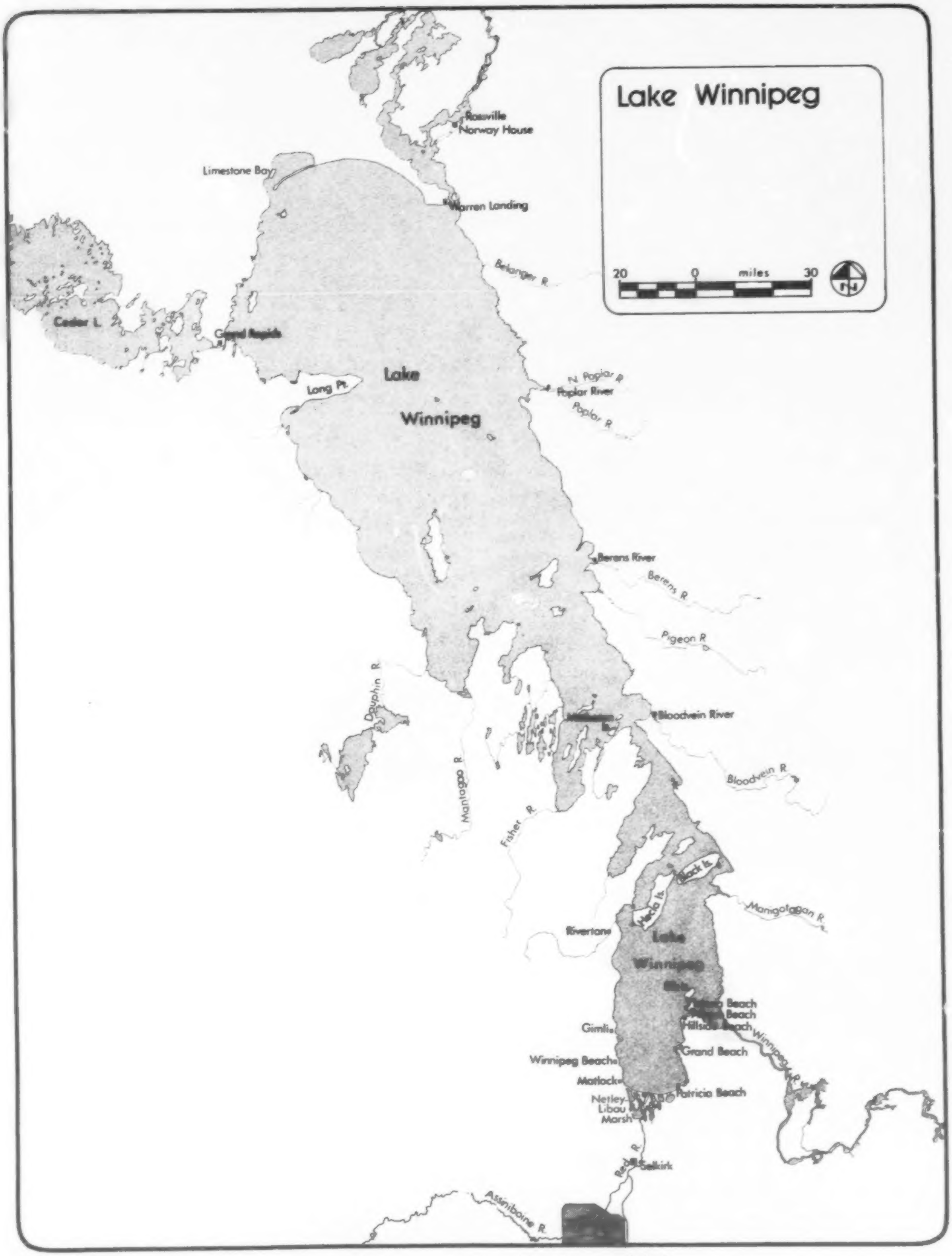

Lake Winnipeg
20
0
miles
30
Rossville
Norway House
Limestone Bay
Warren Landing
Belanger R.
Cedar L.
Grand Rapids
Lake
Winnipeg
Long Pt.
N. Poplar R.
Poplar River
Poplar R.
Berens River
Berens R.
Pigeon R.
Dauphin R.
Bloodvein River
Bloodvein R.
Mantagao R.
Fisher R.
Black Is.
Hecla Is.
Manigotagan R.
Riverton
Lake
Winnipeg
Beach
Beach
Hillside Beach
Winnipeg R.
Gimli
Grand Beach
Winnipeg Beach
Matlock
Patricia Beach
Netley
Libau
Marsh
Red R.
Selkirk
Assiniboine R.

Fig. 5-2. Location of Communities on Lake Winnipeg, 1973.

# EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE PHYSICAL ENVIRONMENT

## WATER REGIME CHANGES

At several locations on Lake Winnipeg water levels are recorded by the Water Survey of Canada, Department of the Environment. However, these recorded levels are affected by upstream storage reservoirs and diversions installed at various points in time during the period of record. Hence water levels recorded at these stations were modified to show what the levels would have been had all existing man-made changes in the basin been in operation over the period 1928-66. The Saskatchewan-Nelson Basin Board[5-1] prepared the data which is referred to as modified historic. The Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management and Manitoba Hydro accepted this data as the water regime which would have prevailed under unregulated conditions. Thus the unregulated condition is represented by the modified historic levels. Data on regulated levels were obtained from Manitoba Hydro. Regulated and unregulated data were prepared for the hydrologic period 1928-66. Recorded water levels are available for the subsequent years including 1974, but the necessary statistical analyses have not been performed to extend the period for the unregulated and regulated conditions.

Based on these computed levels, the average mean monthly level of Lake Winnipeg during 1928-66, was 713.35 ft. With regulation of discharges from Lake Winnipeg and the Outlet Lakes, the average mean monthly level is anticipated to be 714 ft. Therefore, on the average, the mean level of Lake Winnipeg will be 0.65 ft higher under regulated conditions.

In accordance with operating conditions outlined in the interim licence, Manitoba Hydro may regulate the levels of Lake Winnipeg between elevations 711 and 715 ft. Under severe drought conditions the lake level could fall below the lower limit of this range (711 ft) and in the event of a major flood, the upper limit (715 ft) could be exceeded. Computed levels for Lake Winnipeg under regulated conditions indicated a fluctuation between a maximum mean monthly of 716.50 ft and a minimum mean monthly of 711.10 ft, a range of 5.40 ft. Based on the modified historic data for 1928-66, lake levels under unregulated conditions would have ranged between a maximum mean monthly of 717.16 ft and a minimum mean monthly of 709.67 ft, a range of 7.49 ft (Table 5-1). Thus under regulation the range between maximum and minimum water levels would be reduced by 2.09 ft.

TABLE 5-1
LAKE WINNIPEG MEAN MONTHLY WATER LEVELS

| Water Level | Regulated | Unregulated | Change |
|---|---|---|---|
| Maximum | 716.50 ft | 717.16 ft | -0.66 ft |
| Average | 714.00 | 713.35 | +0.65 |
| Minimum | 711.10 | 709.67 | +1.43 |

NOTE: *Based on modified historic data for the period 1928-66.*

Water levels for Lake Winnipeg under regulated and unregulated conditions are depicted in Fig. 5-3.

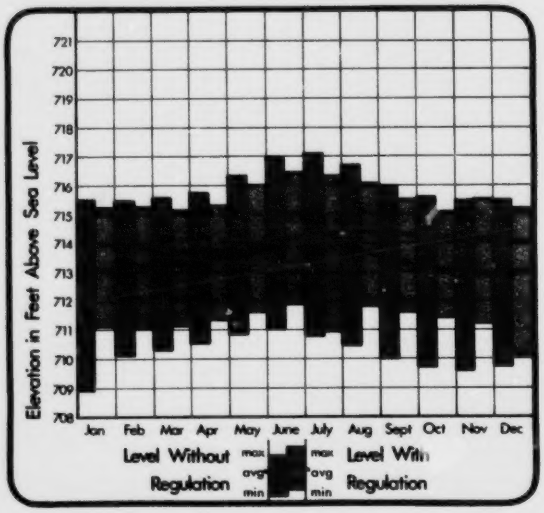


Fig. 5-3.
Lake Winnipeg Water Levels.

Under regulated conditions the average mean monthly level for all months of the year will be slightly higher than under unregulated conditions. Regulated minimum mean monthly water levels will be higher for each month of the year than unregulated minimum mean monthly levels. With regulation, the maximum mean monthly water levels for all months of the year, except November, will be lower than the maximum mean monthly levels without regulation.

It should be noted that wind set-up and wave action are not changed by regulation. When the wind blows over a body of water the surface water will begin to move in the direction of the wind and will pile up against the windward shore. The height that the water is piled up, measured above the still water level, is referred to as set-up. The highest set-up was recorded at 3.78 ft on October 3, 1970, in the Gimli-Winnipeg Beach area. It has been observed that the recorded lake set-ups and the incidence of lake set-up increases as the open water season progresses. For example, there is only a 5 percent risk of having a set-up of one foot or more on any given day in June while in October there is a 10 percent chance of a set-up of one foot or more on any given day. The maximum recorded set-up in June is 2.57 ft while the maximum recorded set-up in October is 3.78 ft.

In addition to wind set-up, waves and wave uprush add to the problem of high water. Unfortunately, records of wave heights on Lake Winnipeg are meagre. Wave heights can be computed from wind speed, wind direction, characteristics of the water body and shoreline configuration. Since shoreline configuration is a significant factor in computing wave height and associated wave uprush, the values vary widely from one beach area to the next.

The modified historic and regulated Lake Winnipeg discharge data are analysed in the following section. The modified historic Lake Winnipeg discharge data were prepared by the Saskatchewan-Nelson Basin Board and have been accepted by both the Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management and Manitoba Hydro. Regulated Lake Winnipeg discharge data were obtained from Manitoba Hydro.

As depicted in Fig. 5-4, under unregulated conditions, average mean monthly discharges are high in summer and low in winter. This situation will be reversed with the regulation of discharges from Lake Winnipeg. Under regulation, average mean monthly discharges will be low in summer and high in winter. Under regulation, there will be extreme high discharges in midsummer during periods of very high inflows to Lake Winnipeg from tributaries within its drainage basin. Changes in average mean monthly discharges between successive months will be greater under regulated conditions than under unregulated conditions. The largest changes in average mean monthly levels under unregulated conditions occurred between March, April and May, and between October, November and December. Under regulated conditions, the largest changes in average mean monthly levels will occur between

February, March and April and between October, November and December.

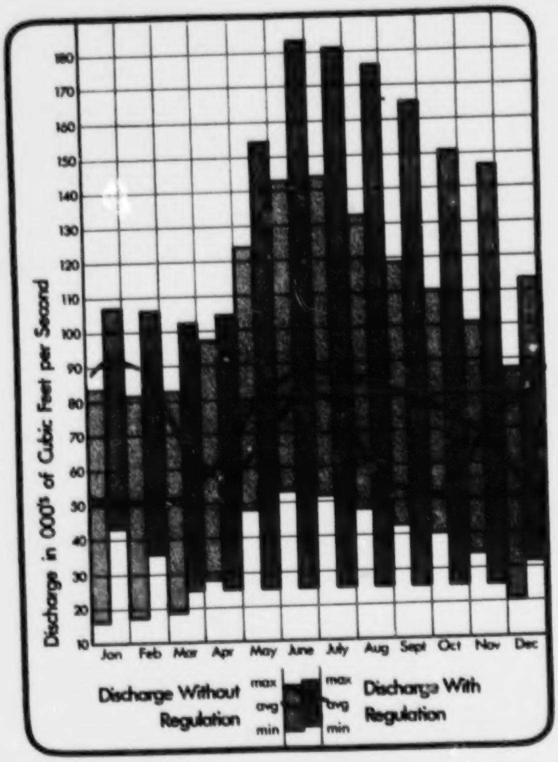


Fig. 5-4.
Lake Winnipeg Discharges.

The modified historic average mean monthly discharge from Lake Winnipeg over the period 1928-66, is 69,800 cubic feet per second (cfs), (Table 5-2). Under regulation, the average mean monthly discharge will be the same. The modified historic minimum mean monthly discharge is 16,300 cfs; with regulation, the minimim mean monthly discharge will be 25,000 cfs, an increase of 8700 cfs. With regulation, the maximum mean monthly discharge will be 183,300 cfs, an increase of 39,300 cfs over the modified historic mean monthly discharge of 144,000 cfs.

TABLE 5-2
LAKE WINNIPEG MEAN MONTHLY FLOWS

| Flows | Regulated | Unregulated | Change |
|---|---|---|---|
| Maximum | 183,300 cfs | 144,000 cfs | +39,300 cfs |
| Average | 69,800 | 69,800 | 0 |
| Minimum | 25,000 | 16,300 | + 8,700 |

NOTE: *Based on modified historic data for the period 1928-66.*

## CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER

The chemical, bacteriological and physical properties of the water flowing through Lake Winnipeg are not anticipated to change due to the regulation of flows from the lake. The Fisheries and Marine Service, Canada Department of the Environment, has reported that it is not anticipated that regulation will change the water quality of Lake Winnipeg because the lake is only going to be raised by less than one foot above mean level, and its range of fluctuation will be maintained within the established high and low levels.

> *The lake* [Winnipeg] *is only going to be raised less than one foot above the mean level, and its range of fluctuation will be maintained within the established high and low levels. These changes are not likely to affect the general productivity of the lake and it is unlikely the future changes in chemical or biological characteristics of the lake can be attributed to Lake Winnipeg regulation.*[5-2]

## PHYSICAL CHANGES TO THE LAKESHORE

The lakeshore of Lake Winnipeg is composed of a variety of shoreline types. The shoreline of the western side of Lake Winnipeg is generally low, composed of clay and till with boulders. Exposed limestone cliffs are found in the vicinity of Matheson Island. The south-eastern shoreline, influenced by the transition zone of the Precambrian shield, is characterized by sandy beaches. In the extreme southern end of the lake where the Red River forms a delta, extensive areas of marsh exist. Investigations into the effects of the regulation project on the lakeshore focused on the changes that will occur in the marshes and on sand beaches.

MARSHES - Marshes of significant size (greater than 500 acres) are found mainly along the southern and western shores of Lake Winnipeg. The Netley-Libau Marsh is the largest. The bottom soils of the southern marshes are usually inorganic muds, muck and peat overlying muck. Dominant emergent plants are hardstem bulrush (*Scirpus acutus*), cattail (*Typha* sp.), and common reed (*Phragmites communis*). Most abundant submergent plants include milfoil (*Myriophyllum* spp.), pondweeds (*Potamogeton* spp.), burreed (*Sparganium angustifolium*) and bladderwort (*Utricularia vulgaris*), (Fig. 5-5).

Fig. 5-5. Photograph of Marsh Area at Folster Lake, South of Lake Winnipeg, 1973.

Periodic fluctuations in water levels are necessary to allow establishment of wide bands of productive emergent and submergent plants. Annual periods of low water are important to encourage a rich variety of submergent and emergent plants. Periodic very low levels are necessary to release nutrients tied up in the undecomposed organic material. Marshes typically show a great increase in productivity in periods following these low levels. In addition, marshes which lose a relatively large proportion of their water reserve during the growing season are more productive of food and cover plants than are those which have high, stable water levels.

EFFECT ON MARSHES - The water regime associated with the regulation of flows from Lake Winnipeg will result in a slightly higher annual mean level, and the elimination of extreme low and high water levels. With the new water regime there will be decreased nutrient turnover in the marsh areas resulting eventually in retarded plant growth. Stagnation will result in the elimination of variety in emergent vegetation. Stable, high water levels result in an anaerobic state which stops vegetative reproduction of emergent plants and leads to die offs and reductions in species.

SHORELINES - Investigation into the effects of the regulation project on shorelines was confined to the southern portion of Lake Winnipeg; south of Riverton on the west shore and Elk Island on the east shore. The study focused on predicting changes in the rate of shoreline erosion, and the transport of sand by water.

Shoreline erosion and recession have been a serious problem on Lake Winnipeg since the foreshore lands were first settled. An associated problem is the movement of sand away from beach areas, particularly during high water periods, causing a deterioration in the quality of these areas. The terms of reference in the Study Agreement provided for investigations of erosion and sedimentation on rivers and lakes affected by the hydroelectric projects. For Lake Winnipeg this involved the determination of the rate of shoreline erosion and the pattern of sand movement under existing conditions to provide a basis for estimating shoreline recession and sand movement under regulated conditions. The Study Board incorporated into its program a study of the shoreline processes on the south basin of Lake Winnipeg which had been initiated by the Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management.

Shoreline Erosion - Historic rates of shoreline recession were determined by plotting on a plan the location of the shoreline as it existed at several different points in time, as derived from land subdivision surveys and aerial photographs. The effect of regulating the level of the lake on shoreline erosion was deduced, utilizing the concept of the equilibrium shore profile. This concept postulates that the shore profile is related to the wave climate and water level regime and that any change in the water level regime causes a corresponding shift in the shore profile if the wave climate remains constant. If the water level rises, the shore profile shifts upward and landward to maintain a constant position relative to the water level.

Since the water levels under any condition are variable, it is necessary to represent the variable levels for each condition by an equivalent single level (hereafter defined to be the effective lake level) which may be associated with the shore profile for that condition. The effective lake level was further defined as a constant level at which the rate of erosion would be the same as under the actual variable levels and was computed on the basis of a model relating the rate of erosion to lake level, wind set-up, wave height and shore profile. The computations utilized a wave energy and wind set-up climate developed on the basis of three seasons of field observations.

The initial change in the rate of erosion following regulation was estimated using the model mentioned earlier. It was postulated that the initial increased rate would decrease to the historic rate as the vertical and horizontal profile shifts occurred.

The shorelines within the south basin of Lake Winnipeg were found to be generally eroding at rates of one to 2 ft per year with extreme values of zero to 25 ft per year. This rate of erosion is attributable to the type of soil (clays, clayey to sandy tills, and outwash sands) forming the shorelines, and to a long-term rise in the level of the south basin resulting from continuing isostatic rebound of the northern outlet of the lake. An advance of the shoreline due to accretion of sand was observed only at docks and breakwaters.

Excluding the marshes at the south end of the lake, the land loss associated with the recorded erosion process amounts to some 15 acres per year.

It is estimated that erosion produces approximately 510,000 tons per year of sediments consisting of 280,000 tons of silts and clays, and 230,000 tons of sands, gravels and boulders. These values may be compared to 2,650,000 tons per year of suspended sediment contributed on the average by the Red River at Lockport.

Sand Transport - The methodology involved a review of the processes causing sand movement, an inventory of sand quantities, and an estimate of sand transport rates. The effects of regulation on beaches and transport rates were assessed. On Lake Winnipeg wave energy dissipation at the shoreline is partially reflected as an erosion process. The size and quantity of beach material generated by erosion is determined by the type of soil being eroded.

The granular beach materials along the east and west shorelines of the lake are derived primarily from the erosion of the land masses along the shore. Along the south shore the beach material is derived from littoral processes acting along east and west shores and, as previously indicated, some contribution is made by the Red River. The lacustrine clays and clayey tills along the west shore contain approximately 15 percent beach material, whereas the sandy tills along the east shore contain approximately 85 percent beach material per volume of soil eroded.

The west shore is deficient in sand for beaches except at Gimli and Winnipeg Beach.

Portions of the south shore have extensive volumes of sand below the water level. Beach ridges and dunes above the water level are generally not extensive and are backed by low-lying marshy land. Development of these sand deposits for beaches is likely possible but would require extensive and costly dredging of sand.

Excellent sand beaches exist along the east shore at Patricia, Grand, Hillside, Victoria and Albert beaches and on Elk Island. Patricia, Grand and Hillside beaches are bay-mouth bars with sand dunes back of the beach. Victoria and Elk Island beaches are formed by the erosion of sandy bluffs. However, there are extensive reaches of shorelines with boulder and cobble beaches (Fig. 5-6).

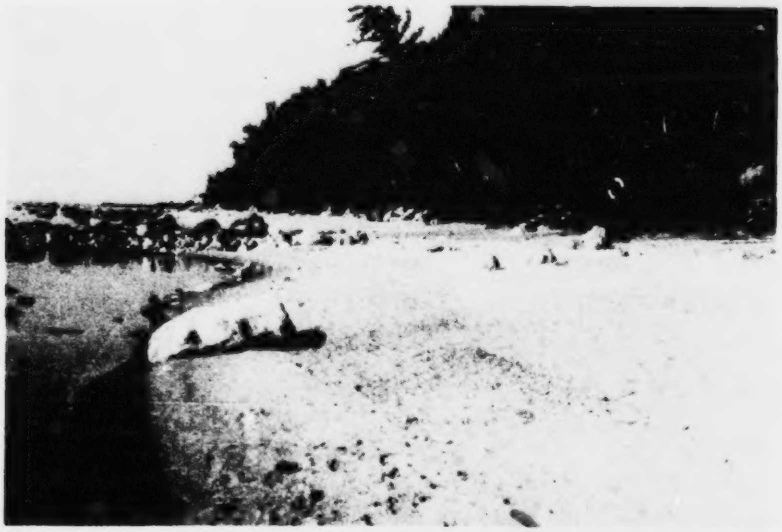


Fig. 5-6. Photograph of a Typical Sand Beach on the South Basin of Lake Winnipeg, 1973.

## EFFECT ON SHORELINES

Effect on Shoreline Erosion - Regulation of discharges from the lake is expected to cause an initial increase in the rate of shoreline erosion. The change from the recorded to the regulated condition will initially increase the rate of shoreline recession by approximately 50 percent. Along the east and west shores the rate of land loss will increase initially from the equilibrium rate of 15 acres per year to 23 acres per year. The rate of erosion is expected to approach the recorded rates as the shore profiles adjust to regulated higher mean water levels. The average rate of land loss over the total profile adjustment period is estimated to be 19 acres per year.

The adjustment of the shore profile to the new higher mean water level will result in a profile rise of typically 0.3 ft to 0.5 ft and a landward profile shift of typically 5 ft to 75 ft. The total area of land associated with this profile adjustment along the east and west shores is approximately 312 acres.

The computed duration of the profile adjustment period and the proportion of the profile shift which may be considered as a damage attributable to the regulation of the lake level depends on the erosion-time model used in the analysis. It is difficult to ascertain the degree to which the following two proposed models apply.

The model giving the lower limits suggests the profile shift would occur over a period of typically 5 to 40 years and that approximately 20 percent (62.5 acres) of the land loss associated with the profile adjustment would be attributable to the regulation of the lake level. On this basis the weighted average time to effect the profile adjustments is approximately 16 years.

The model giving the upper limits suggests the profile shift would occur over a period of typically 20 to 200 years and implies that 100 percent (312 acres) of the land loss associated with the profile shift would be attributable to the regulation of the lake level. On this basis the weighted average time to effect the profile adjustments is approximately 80 years. It should be noted that the total land loss during this time period would be approximately 1500 acres.

Effect on Sand Beaches - The profiles on Lake Winnipeg have a distinct change in profile gradient at elevation 713.0 ft. Where the top of the bank is at elevation 721.0 ft or higher, the upper limit of the beach sand on a profile is at elevation 718.0 ft. In some cases where storm ridges and sand dunes occur, the beach material may be considered to extend above elevation 718.0 ft. However, for recreation purposes, the people using the beach are interested primarily in the band of beach occurring on a profile between elevations 713.0 ft and 718.0 ft. The profiles will suffer a loss in beach width until a new equilibrium profile is established. The band of beach between elevations 713.0 ft and 718.0 ft will be reduced by approximately 20 percent for each 1.0 ft rise in water level over the recorded long-term mean elevation of 713.2 ft. During the open water season, for 50 percent of the time or less, the regulated water levels will be from 0.5 ft to 1.5 ft higher resulting in a 10 to 30 percent reduction in beach width.

Along the west shore the increase in wave energy reaching the shoreline during the profile adjustment stage is expected to increase the rate at which sand is transported along the shore. Concurrently, the generation of sand as an erosion product will increase. It is anticipated that the two effects will compensate each other and that the net effect will be a minor change in the availability of sand; in some areas an increase and in others a decrease.

Along the south shore and at Patricia Beach the profile adjustment associated with regulation of the lake is expected to cause the shoreline to recede landward approximately 50 ft over a period estimated in the range of 10 to 50 years.

At Grand, Hillside and Victoria beaches and at Elk Island it is estimated that the profile adjustment associated with regulation will cause the shoreline to recede landward some 5 to 10 ft over a period of 5 to 25 years.

# EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION

## LIMNOLOGY AND FISHERIES

LIMNOLOGY - Studies on the limnology of northern lakes within the study area were conducted for the Board by the Freshwater Institute, Fisheries and Marine Service, Canada Department of the Environment. The Study Board approved the designation of 90 percent of the funding for fisheries-limnologic studies on Southern Indian Lake, and on the Rat-Burntwood river system. The remainder was used to examine the Outlet Lakes and lakes on the lower Churchill River.

EFFECT ON LIMNOLOGY - Lake Winnipeg was not studied in detail during the course of the fisheries-limnologic investigations because the ecological implications of regulation appeared to be minimal. The Fisheries-Limnology study group concluded:

> *Lake Winnipeg is excluded because the ecological implications appear to be minimal. The lake is only going to be raised less than one foot above the mean level, and its range of fluctuations will be maintained within the established high and low levels. These changes are not likely to affect the general productivity of the lake and it is unlikely that future changes in chemical or biological characteristics of the lake can be attributed to Lake Winnipeg regulation. Phytoplankton, zooplankton, zoobenthos, and fish populations and production will likely be unaffected and the availability of commercial species to standard commercial* [fishing] *gear is likely to remain unchanged.*[5-3]

FISHERIES - The limnology and fisheries of Lake Winnipeg were examined in a report entitled "Program for Regulation of Lake Winnipeg", prepared in 1972 by the Manitoba Department of Mines, Resources and Environmental Management, and Manitoba Hydro.

> *The Freshwater Institute of the Canada Department of the Environment has recently carried out some preliminary limnological studies of Lake Winnipeg. Based on data gathered in the course of*

these studies experts from the Institute indicated that although the flushing rates of the lake will be decreased slightly as a result of regulation no serious detrimental effect to the minute free floating plant organisms in the Lake, which form the primary component of the food chain, will result. Changes in the littoral algae community are expected to be only temporary.[5-4]

The fisheries resource of Lake Winnipeg and the immediately adjacent tributary waters is the largest in Manitoba, ... Fish contribute to jobs and income, provide a commodity for trade and commerce, and a high quality food product through commercial fishing; they are the recreational basis of sport fishing; and fish provide food for residents in remote communities, as well as feed for ranch mink.

## Commercial Fishing

For the five years preceding the closure of Lake Winnipeg in the spring of 1970 because of mercury contamination, there was an annual average of 1,300 licensed fishermen in the open water season and 300 in the winter, plus an additional 300 support jobs in fishing on the lake. They sold annually 7 1/3 million pounds, in a fishery which was declining gradually in recent years possibly owing to overfishing. These fish were worth $1 1/3 million to the fishermen, and $2 1/4 million as marketed for export f.o.b. Winnipeg. Although some 14 species or groups of fish are caught commercially in Lake Winnipeg, only about one-half this number are important in volume or value, and the fishery depend mostly upon sauger, whitefish, pickerel (walleye), pike, tullibee and sucker (mullet).

## Sport Fishing

The extend and value of angling in Lake Winnipeg are difficult to estimate. A reasonable guess, based upon answers to questions asked of every purchaser of a Manitoba angling license, is that between 5 and 10 percent of all the angling in Manitoba is done in Lake Winnipeg and tributary rivers up as far

> *as the first dam* [on the Winnipeg River]. *This would amount to between 50,000 and 100,000 angler days, representing an estimated gross annual expenditure associated with Lake Winnipeg angling of between one-half and one million dollars. Principal species sought are pickerel and pike.*
>
> ### *Domestic Fishing*
>
> *Domestic fishing is the harvest of fish to eat by people in remote communities. Registered Indians may take fish for their own use, and a permit for settlers used to be in effect. There is no record of the amount caught, but a reasonable estimate would be 120,000 lbs. (400 lbs. x 300 days) worth about $12,000.00.*
>
> ### *Mink Ranch Fishing*
>
> *The demand for fish to feed the mink varies with the prosperity of the ranch mink industry, presently at a low ebb. During 1970/71, the reported catch by 8 "spring" creeks licensees and 27 mink food permittees was about 430,000 lbs. worth $13,000.00.*
>
> ### *Value of Fishery*
>
> *The annual value of the Lake Winnipeg fishery - expressed as the marketed value of the commercial catch, estimated gross expenditures in sport fishing, and value as domestic food and ranch mink feed - is about $3,000,000.*[5-5]

EFFECT ON FISHERIES - As indicated in the previous section, the Fisheries-Limnology study group did not anticipate that the general productivity of Lake Winnipeg would be significantly affected by the changes associated with regulation. The availability of commercial species to standard gear used in the commercial fishery is expected to remain unchanged.

The commercial fish catch on Lake Winnipeg in the open water season is transported by boat or barge to Selkirk or Winnipeg and thence by truck to the Freshwater Fish Marketing Corporation plant in Transcona. Since the present navigation routes will not be affected by the regulation of Lake Winnipeg, the method of collecting and transporting fish (boat or barge) should not be altered. The same consideration is expected to apply to fish caught in the winter which are brought to the major collection points by snowmobiles and power toboggans for furtherance to the plant.

## WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE

WILDLIFE HABITAT AND POPULATIONS - The Study Board engaged a private consulting firm to conduct the wildlife resource studies. The program began in late August 1972, and continued until March, 1974. The wildlife study group evaluated available information and conducted wildlife surveys. The main objectives in each of the study areas were to identify the nature and extent of probable effects of the hydroelectric projects on wildlife populations, habitats, wildlife resource uses, and wildlife management with emphasis upon critical areas and subsequently to suggest procedures and programs which would prevent, minimize, or mitigate against adverse effects of the projects to wildlife populations.

Field work on Lake Winnipeg consisted of aerial waterfowl surveys of marshes and shorelines. Waterbird nesting colonies throughout the lake were inspected, noting species present, numbers and locations of nests, reproductive success and island characteristics.

The major value of Lake Winnipeg to most wildlife species lies in the 150 square miles of marsh occurring along its southern and south-western shores. Marshes of the Red River plain and Red River delta are the most fertile in the area. The largest of these marshes, Netley-Libau (86 square miles), has historically been an important waterfowl and furbearer habitat.

Furbearers - Muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), mink (*Mustela vison*), lynx (*Lynx canadensis*), otter (*Lutra canadensis*) and fisher (*Martes pennanti*) inhabit the shorelines of Lake Winnipeg, its marsh areas, and streams flowing into the lake. Some indication of the current status of furbearers which may be affected by regulation can be obtained by examining habitat and population levels of muskrat.

Good muskrat habitat is dependent upon an adequate supply of rooted aquatic vegetation and a favourable water regime especially during house building (fall) periods. Some large areas of suitable vegetation are found in the southern marshes of Lake Winnipeg which historically have contained large muskrat populations. Netley-Libau Marsh has supported a population of 277,000 muskrats (five per acre) during peak years, e.g. 1954. Current populations may be as low as 3000 (0.05 per acre). Low water levels during spring and summer and extreme wind set-ups during the fall of 1973 are the probable causes of current extremely low populations. High water levels of 1970 damaged levees, allowing water to fluctuate greatly even at the far reaches of the marsh.

Waterfowl - Little of Lake Winnipeg's shoreline is good waterfowl habitat. Consequently, waterfowl in the area make little use of the general shoreline, but do make extensive use of the 150 square miles of marshes (Fig. 5-7). Some of these marshes are important for staging waterfowl while others are important for production and staging.

At the southern end of the lake there are nine major marshes. Netley-Libau, the largest marsh, has a large amount of potentially productive waterfowl habitat. However, fluctuating water levels limit the value of the marsh to nesting waterfowl. Production is restricted in the area by rapid inundation due to wind set-up.

According to the Canada Land Inventory, some areas along the northern shores are also used by staging waterfowl, primarily ducks (Fig. 5-7). Riverton-Hecla marsh, Fisher Bay inner marsh, and Willow Point marsh are the only other shoreline areas with moderately high productive capabilities. Several marshes, including Washow and Fisher bays, are important migration stopovers, but have limited value as waterfowl production areas.

Numbers of breeding ducks were generally low in most areas during 1973. There were twenty breeding pairs of waterfowl per square mile, or 5.2 per mile of shore (adjusted figure) in the major marshes during early June, 1973. The most abundant species using the lake in summer were the mallard (*Anas platyrhynchos*) and blue-winged teal (*Anas discors*). These dabbling ducks prefer sheltered areas with suitable aquatic vegetation. Diving ducks in the area include the lesser scaup (*Aythya affinis*) and the redhead (*Aythya americana*). A few Canada geese (*Branta canadensis*) nest in the area around Hecla Island and the Riverton marsh.

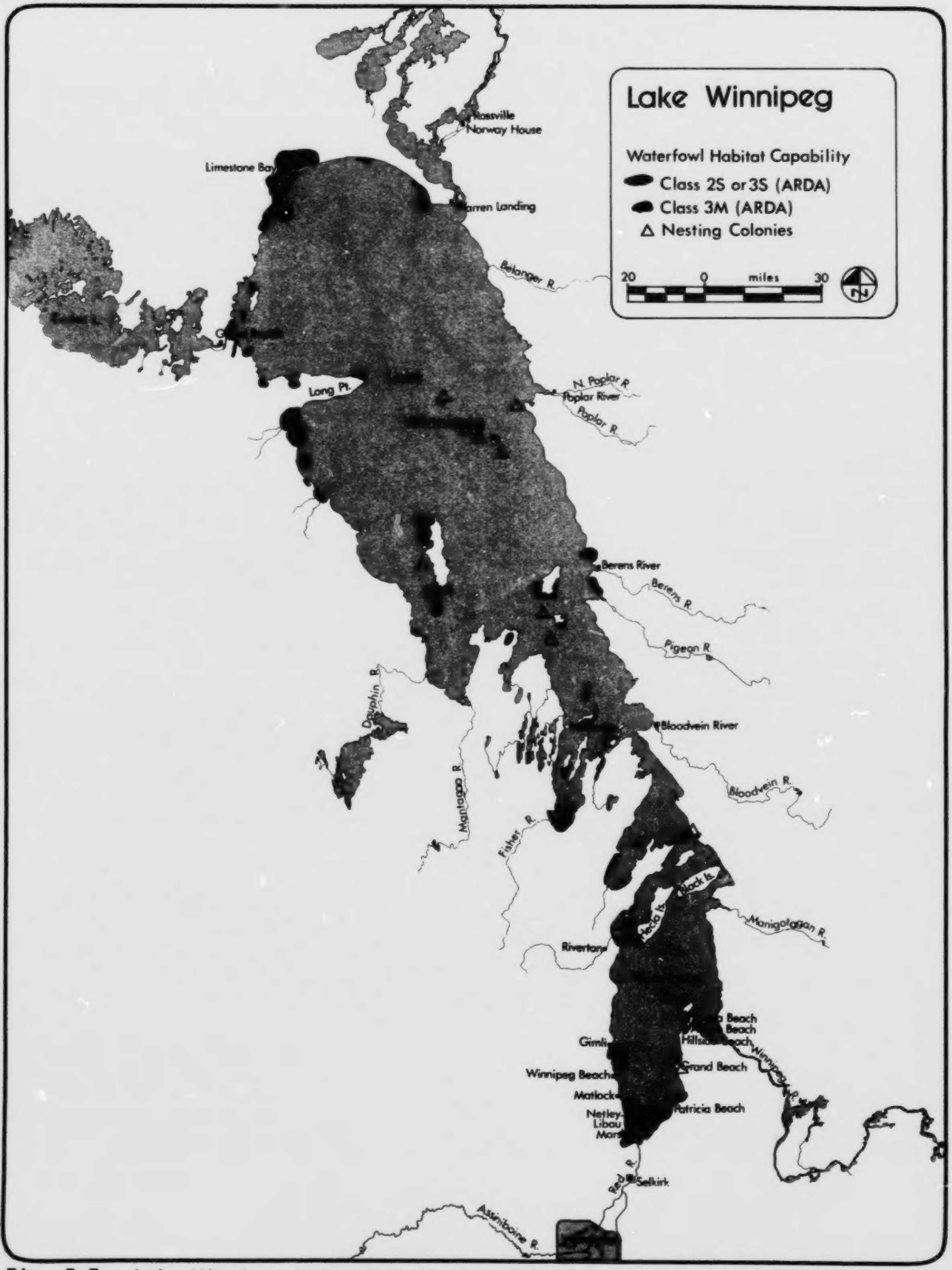

Lake Winnipeg
Waterfowl Habitat Capability
Class 2S or 3S (ARDA)
Class 3M (ARDA)
△ Nesting Colonies
20
0
miles
30
Rossville
Norway House
Limestone Bay
Warren Landing
Belanger R.
Long Pt.
N. Poplar R.
Poplar River
Poplar R.
Berens River
Berens R.
Pigeon R.
Bloodvein River
Bloodvein R.
Dauphin R.
Mantagao R.
Fisher R.
Hecla Is.
Black Is.
Manigotagan R.
Riverton
Beach
Beach
Gimli
Hillside Beach
Winnipeg R.
Grand Beach
Winnipeg Beach
Matlock
Patricia Beach
Netley-Libau Mars
Red R.
Selkirk
Assiniboine R.

Fig. 5-7. Lake Winnipeg Waterbird Nesting Colonies and Waterfowl Habitat Capability.

Substantial numbers of waterfowl use Lake Winnipeg as a staging area in late summer and as a migration route in fall and spring. As many as 48,000 waterfowl have been estimated on Netley-Libau Marsh during peak years. With the arrival of fall flights, numbers peak in late September and early October.

The value of Lake Winnipeg to moulting and staging waterfowl is not as high at present as it has been in years of higher waterfowl populations and lower water levels. Numbers of dabblers staging on Netley-Libau Marsh have been estimated to exceed 40,000 in years of low water levels, but in 1973 approximately 24,000 were tallied.

Large flocks of Canada geese appear in early September and collect in Washow Bay, Fisher Bay, Riverton and Sturgeon Bay marshes. Snow geese (*Chen caerulescens*) use the marshes and bays along Lake Winnipeg, occasionally in large numbers. Migration stopovers of snow geese depend to a great extent on weather conditions.

Colonial Nesting Birds - Several species of waterbirds have established colonial nesting sites on the reefs, islands and in marshes of Lake Winnipeg (Fig. 5-7).

Four colonies of the white pelican (*Pelecanus erythrorhynchos*) have been identified on the lake (Fig. 5-7). Lake Winnipeg has 6 percent of the total Canadian breeding population of this large bird. The numbers of pelicans appear to have increased in the large colony at Pipestone Rock, located off the east shore opposite Grindstone Point, where the majority of nests are high above water level. A large colony (three reef islands) also exists near the St. Martin Islands located south of Reindeer Island. Pelicans also use the southern marshes of the lake, probably for feeding.

The double-crested cormorant (*Phalacrocorax auritus*) also nests on islands in Lake Winnipeg, often with pelicans (Fig. 5-8). The largest colonies are at Pipestone Rock and the St. Martin Islands. A total of eleven nesting colonies have been reported on the lake.

The great blue heron (*Ardea herodias*) also nests in the area. Thirty percent of the estimated 4000 pairs in Canada nest in the Lake Winnipeg-Lake Winnipegosis area. Heronries are usually in large trees, often trembling aspen, and over dry land. Marsh areas are used to obtain food.

Gulls and terns nest throughout the area, on low, sandy or rocky reef islands and in marshes, depending on species preference. Colonies of Caspian terns (*Hydroprogne caspia*) may be the largest in the prairie provinces. At least two colonies of western grebes (*Aechmophorus occidentalis*) exist in the southern marshes of Lake Winnipeg.

Fig. 5-8. Photograph of Young Pelicans and Cormorants on Pipestone Island in the South Basin of Lake Winnipeg, 1973.

## EFFECT ON WILDLIFE HABITAT AND POPULATIONS

Effect on Furbearers - As previously indicated, good muskrat habitat is dependent upon an adequate supply of aquatic vegetation. Large marsh areas are found along the southern shores of Lake Winnipeg which have historically contained large muskrat populations.

With the new water regime there will be decreased nutrient turnover in the marsh areas resulting eventually in retarded plant growth. Smaller areas of less suitable vegetation will limit muskrat habitat.

Muskrat require stable water levels during fall (house building) and winter periods. The proposed high, stable lake levels under regulation will result in a short-term increase (3 to 4 years) in muskrats, followed by a decline. Preferred food and cover plants could flourish with raised water levels, with a concomitant increase in muskrat numbers. Subsequently, populations are expected to decline as stagnation decreases variety in emergent vegetation.

Effect on Waterfowl - During the 1940's when lake levels were approximately 710 ft to 712 ft, there were 35,000 acres of highly productive marsh, hayfields and small areas of open water in Netley-Libau Marsh. There were fifty small lakes in the marsh. As water levels rose throughout the 1960's, 10,000 acres disappeared, and seventeen large lakes replaced the fifty smaller ones.

Prolonged productivity in the reed swamps of Lake Winnipeg, such as the Netley-Libau Marsh, is dependent on good aerobic conditions in the soil. Stable, high water levels result in an anaerobic state which stops vegetative reproduction of the emergent plants and leads to eventual die offs.

Peak waterfowl use and production on Netley-Libau Marsh have been directly correlated with periods of low water. During these periods, heaviest use was made of the marshes by dabbling species.

With the increased stability of the water levels under regulation and elimination of the periodic low cycles, productivity of the marshes on Lake Winnipeg in terms of ducks will be less in some years than under unregulated conditions. Autumn use of the marsh could also decline on the average.

Under regulated conditions water levels will remain high throughout August and September. Under unregulated conditions, reductions of levels towards the end of the summer make available vegetation and invertebrates sought by staging ducks.

The value to both dabbling and diving ducks will decrease as the amount and quality of nesting habitat decreases.

Diving ducks will be less affected during staging periods as they prefer more open water than dabblers.

Effect on Colonial Nesting Birds - The effect of the higher mean levels on colonial nesting species is unknown, although there will be some loss of satellite colonies on low islands. The response to the lowered productivity of the marshes is an unknown factor, but is not expected to be significant. Beach nesters such as Caspian terns and common terns (*Sterna hirundo*) will be affected to the greatest extent by higher water levels.

## WILDLIFE USE

Waterfowl Hunting - Marshes on Lake Winnipeg have been important to waterfowl hunters in Manitoba largely because of their high fall populations and close proximity to Winnipeg. Winnipeg hunters comprise almost one-half of the waterfowl hunters in the province.

Netley-Libau Marsh has traditionally been a favourite hunting area for

Winnipeg waterfowl hunters. Many hunting camps dot the shorelines. Harvests are highest in the early part of the season, generally a mixture of dabbling ducks and resident "divers". Blue-winged teal are well represented in hunters' bags before departure in the first week of October. Diving ducks, predominantly lesser scaup, are shot in greater numbers as the season progresses.

Hunting of Canada geese is increasing as the populations rise. The interlake population of giant Canada geese is increasing and use of marshes along the western shores of Lake Winnipeg in fall offers hunters excellent opportunity. Snow geese occasionally stop on Lake Winnipeg providing further variety in the species of waterfowl available to hunters.

Trapping - Most of the lake is included in registered trapline sections, except for the southern portion. Those areas not in registered traplines are open to any trapper. Beaver, mink, lynx, fisher and muskrat are found along lake shorelines, in marshes, and along streams flowing into the lake.

Marshes in the southern portion of Lake Winnipeg provide large areas of potential muskrat habitat. While 1973 populations were low (perhaps as low as 3000 animals), in good years, e.g. 1954, when numbers have been high in Netley-Libau Marsh, a harvest of 125,000 pelts has been realized from an estimated population of 277,000 animals.

EFFECT ON WILDLIFE USE - Use of this resource usually parallels numbers and availability of favoured species. Hunting success is directly related to populations while trapping effort and success are related to populations but are also dependent on fur prices.

Effect on Waterfowl Hunting - Some of the attractiveness of the Lake Winnipeg marshes to waterfowl will be lost with the stable, raised levels. Productivity of waterfowl will decline as nesting sites and abundance and variety of preferred food species decrease with stagnating marsh conditions. This will mean fewer local ducks available to hunters in fall. The most productive water regime for waterfowl is one which is highest in summer and low in fall, thus affording better access to food. Water levels will remain high throughout the fall under regulated conditions. Attractiveness of the marshes to staging waterfowl, especially dabbling ducks, therefore, may be decreased as overall productivity declines.

All of these factors will combine to affect waterfowl use of Lake Winnipeg marshes. There will be a related effect on hunting.

Effect on Trapping - Numbers of muskrats are expected to peak 3 to 4 years after regulation begins and decline after that period as marsh conditions deteriorate. Trapping success will follow the same pattern.

Other species of furbearers will be affected less, as dependence is not as high on marsh habitat.

## FOREST RESOURCES AND FORESTRY

FOREST RESOURCES - The Study Board did not carry out a survey of the forest resources, forestry operations, and the forest products processing industry in the Lake Winnipeg area. However, the effects of the regulation project on the resources and their utilization have been examined in previous investigations which reported that no adverse effects could be anticipated, and that the expected effect of regulation on forestry will be minimal.

EFFECT ON FOREST RESOURCES - The report, entitled "Program for Regulation of Lake Winnipeg", stated:

> *As the new level of Lake Winnipeg will be contained within the limits which existed in the natural condition in the past, no flooding of productive forested land and no adverse effects on forests caused by lake regulation are expected.*[5-6]

FORESTRY - The major forest products processor in the Lake Winnipeg area is Abitibi Manitoba Paper Ltd. whose newsprint producing plant is located at Pine Falls. In its submission to the Province of Manitoba Royal Commission Inquiry into Northern Transportation in 1967, the company stated that of 176,000 cords of pulpwood involved in its operations in 1966-67, 7100 cords were moved by barge. Pulpwood is transported from the forest Management Units on the lake by barge to the plant at Pine Falls.

EFFECT ON FORESTRY - It is not anticipated that Lake Winnipeg regulation will reduce the harvest of pulpwood and other forest products. Similarly, the routes used for navigation on Lake Winnipeg are expected to remain unaffected by lake regulation. It is reasonable to conclude, therefore, that barge transportation of forest products will be unaltered.

## MINERAL RESOURCES AND MINING

The Study Board did not undertake an investigation of the mineral resources and the mining industry within the Lake Winnipeg area.

MINERAL RESOURCES - The mineral potential of the Canadian shield area of northern Manitoba was established in a federal-provincial co-operative study in 1972.[5-7] The study was prepared on the basis of geological opinion gathered by means of questionnaires. These endowment estimates do not constitute a forecast of what actually will be found and mined. The results represent estimates of the occurrence of undiscovered mineral deposits (down to currently mineable depths), most of which could now be economically exploited. Some would currently be marginally economic, but could be expected to become economic within two decades as a result of technological advances in mining efficiency or by better developed infrastructures.

In the Lake Winnipeg area the geological regions are Winnipeg River-Rice Lakes (4533 square miles) and Lake Winnipeg East (20,321 square miles). The Lake Winnipeg East Region had the lowest aggregate mineral endowment value in the study area - $46,000 per square mile. In terms of aggregate metal value, mineral endowments adjacent to Lake Winnipeg are largest in the Manigotagan-Hole River-Wanipigow area, followed by the Rice River, Anderson Point (Washow Bay) and Bullhead areas.

MINING - An earlier study, "Report on Lake Winnipeg Regulation", by G. E. Crippen and Associates Ltd., January, 1970, had examined the mineral resources of the area and discussed the effects of regulation on mining and exploration activity. It notes that mining and exploration activity is chiefly confined to the eastern shore of Lake Winnipeg south of The Narrows and that there was no exploitation of minerals around the northern lakeshores.

Principal areas of production are Black Island and Deer Island. A silica sand quarry operated on the south shore of Black Island produces 60,000 tons per year. The sand is transported by barge to Selkirk for processing. The floor of the silica sand pit is at elevation 719 ft and the beds dip towards the west at 10 ft per mile. This operation could be expanded considerably. There are registered claims on the northwest shore of Deer Island and a plant utilizing shale has been in production since 1970. The shale outcrops are 15 ft above the mean lake level.

Deposits of white kaolinite clay suitable for ceramic wares exist on the north east shoreline of Lake Winnipeg and extend out into the lake. Samples had indicated that talc and soapstone deposits exist on the small islands in Wanipigow Bay, east of Black Island. If developed, production might amount to a few thousand tons per year. A deposit of iron oxide mixed with calcite lies at an elevation of 716 ft on the south shore of Black Island. There has been interest in this deposit as a possible source of iron oxide for manufacture of Portland cement.

The 1970 G. E. Crippen and Associates Ltd. report noted that

> *The water levels resulting from the regulation scheme being considered will not fall outside the historical range of variation, and there is slight limitation of that range. Accordingly, mineral operations should not be detrimentally affected by regulation.*

## OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION

Prior to the signing of the Study Agreement, the Manitoba Department of Tourism, Recreation and Cultural Affairs initiated a study to project recreation demand and future use of beaches on the south basin of Lake Winnipeg. Subsequently the Study Board assumed the funding of this study.

USE OF OUTDOOR RECREATION RESOURCES - Based on a survey of 1000 residents of Winnipeg, the study concluded that the south basin was heavily utilized by residents of Winnipeg and that the opportunity to participate in water-oriented recreation activities, especially swimming, was the major attraction of the area. The dominance of water-oriented activities is shown in Fig. 5-9. The survey results were used to project future recreation use of the area for 1980. An adjusted and unadjusted projection was made for each year. The unadjusted projection was based solely on population increases and increases in leisure time. No consideration was given to resource limitations, altered environments, or new development programs. This projection was then adjusted to reflect the more obvious resource limitations and new development programs. The difference between these two projections was assumed to be demand that exceeded the physical capabilities of the area, i.e., excess demand.

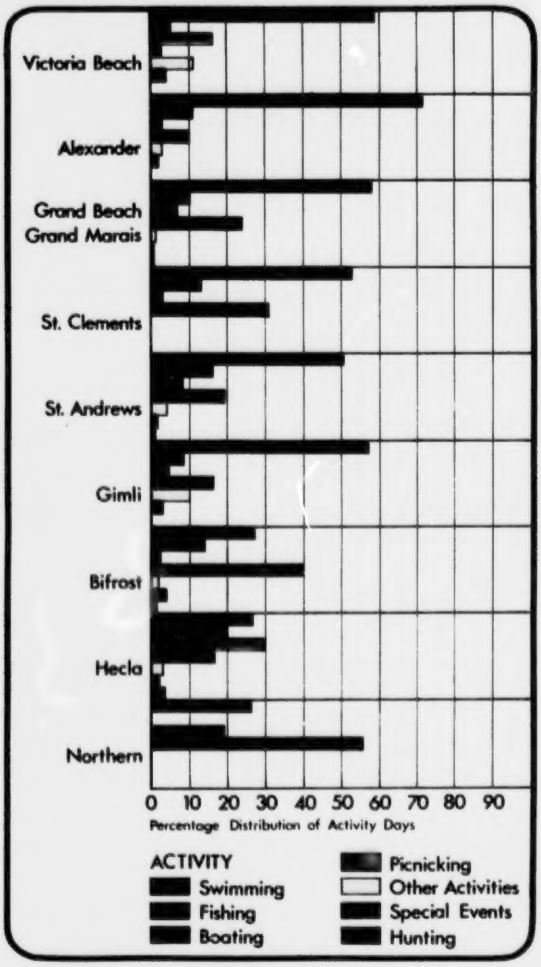


Fig. 5-9.
Percentage Distribution of Recreation Activity Days by Activity by Areas, Lake Winnipeg, Summer, 1971.

The study results indicated that overcrowding of the recreation beach areas on Lake Winnipeg was already occurring, and that to expect existing developed beach areas to accommodate the growth in demand between now and 1980 was unrealistic. It was estimated that an excess in demand over existing capacity of 222,195 activity days would occur by 1980 (Table 5-3). An activity day was defined as one person participating at least once in a given activity on a given day in a specific area.

TABLE 5-3
SUMMARY OF EXCESS RECREATION DEMANDS IN ACTIVITY DAYS, LAKE WINNIPEG, 1980.

| Area | Unadjusted demand in activity days 1980 | Adjusted demand in activity days 1980 | Excess demand in activity days 1980 |
|---|---|---|---|
| Victoria Beach | 495,980 | 400,827 | + 95,154 |
| Alexander | 236,405 | 283,485 | - 47,077 |
| Grand Beach-Grand Marais | 1,127,206 | 937,566 | +189,639 |
| St. Clements | 126,999 | 153,141 | - 26,142 |
| St. Andrews | 666,098 | 622,566 | + 43,601 |
| Gimli | 531,794 | 536,807 | - 5,013 |
| Bifrost | 53,878 | 57,769 | - 3,893 |
| Fisher | N/A | N/A | N/A |
| Hecla Island-Grindstone Point | 44,375 | 59,177 | - 14,802 |
| All other areas | 10,353 | 19,625 | - 9,272 |
| Excess demand | | | 222,195 |

N/A - *Not applicable.*

EFFECT ON OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION - In order to determine the effect of regulating discharges from Lake Winnipeg on the use of beaches along the south basin, the relationship among lake levels, beach width, and beach use had to be established. By comparing data collected over past years on the use of the provincial park at Grand Beach, with mean July-August lake levels, the Manitoba Department of Tourism, Recreation and Cultural Affairs concluded that there appears to be no relationship between these two factors.

As indicated elsewhere in this report, the study of Lake Winnipeg shoreline erosion, sand movement and ice effects, prepared by the Water Resources Branch of the Manitoba Department of Mines, Resources and Environmental Management, estimated that beach width will be reduced with regulation by approximately 20 percent for each foot of increase in the water level. The long-term mean monthly water levels for Lake Winnipeg during July and August for regulated and unregulated conditions are shown in Table 5-4. With regulation, the average July water level will increase 0.36 ft and the average August level will increase 0.58 ft. These water level increases would reduce beach width on average by 7.2 percent in July and 11.6 percent in August.

TABLE 5-4
LAKE WINNIPEG JULY AND AUGUST MEAN MONTHLY WATER LEVELS

| Water Level | JULY Regulated | JULY Unregulated | JULY Change | AUGUST Regulated | AUGUST Unregulated | AUGUST Change |
|---|---|---|---|---|---|---|
| Maximum | 716.40 ft | 717.16 ft | -0.76 ft | 716.12 ft | 716.77 ft | -0.65 ft |
| Average | 714.26 | 713.90 | +0.36 | 714.32 | 713.74 | +0.58 |
| Minimum | 711.98 | 710.82 | +1.16 | 711.86 | 710.46 | +1.40 |

*NOTE: Based on modified historic data for the period 1928-66.*

Examination of data collected over past years on the recreation use of Grand Beach Provincial Park and mean lake levels in July and August indicates no direct relationship between lake levels and recreation use of the beach areas. For example, the average relationship between water level increase and loss of beach area was estimated to be a 20 percent loss of beach width for each one foot increase in water levels above the mean level. In summer, 1974, water levels were approximately 4 ft above the mean level. On the basis of the above relationship, the loss in beach width was estimated to be 80 percent at Grand Beach. However the information available indicates that the loss in recreation use of the area was only 20 percent of the expected use.

It should be noted, moreover, that the level of loss in park use might either increase or decrease if extreme water levels persisted over time. A recurrence of high lake levels such as obtained in the summer of 1974, would serve to aggravate the existing pressure on beach resources.

Inasmuch as there appears to be no relationship between the levels of the lake and the use of the recreation resource, with the possible exception of extreme high levels such as experienced in 1974, the marginal annual average reduction in beach width with regulation (approximately 15 percent) should have no significant effect on recreation demand or on recreation uses of the south basin of Lake Winnipeg.

The regulation of Lake Winnipeg is expected to have a two-fold effect on the transportation and navigation facilities associated with the use of recreation resources in the south basin of Lake Winnipeg. Under regulated conditions, the local road network which provides access to recreation sites will not be seriously affected by the higher mean water levels. In the case of navigation for recreation purposes, it is anticipated that the reduced occurrence of low lake levels will aid navigation by small craft, p[illegible] in shallow harbours.

## TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES

TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES - The Study Board authorized a study of the implications of the hydroelectric projects to transportation and navigation facilities and services in each study area. The method of analysis for each area was basically the same: an inventory of the existing and proposed transportation infrastructure and examination of the physical effects of hydro development on this infrastructure; existing methods of transporting resource products and the implications of hydro development; and, existing transportation services to the communities and possible modifications to the services resulting from hydro development.

In the case of Lake Winnipeg, the study area extended from the Red River delta to the northern extremity of the lake, including all communities and transportation infrastructure adjacent to the lake. The southern section is served by the provincial highway network and contains branches of both the Canadian National and Canadian Pacific railways. There are a number of marine freight handling centres on Lake Winnipeg including Matheson Island, Berens River, Bloodvein and Poplar River. The area has a number of airstrips and floatplane bases. Communities on the north and east sides of the lake are served by winter road and scheduled air transport. Under the Canada-Manitoba Interim Subsidiary Agreement on the Manitoba Northlands (for the fiscal year 1974-75) there is provision for highway preengineering and design studies for the purpose of locating and designing extensions of the existing highway system in northern Manitoba including an all-weather road from Manigotagan to Berens River. Existing transportation facilities and services to the communities located on Lake Winnipeg facilitate the importation of consumer commodities such as food and fuel and the exportation of resource products such as fish and pulpwood, and provide the means of access to and from the communities.

EFFECT ON TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES - The transportation facilities include all-weather roads, winter roads, railways, lake navigation routes, airstrips and floatplane bases. These facilities will not be adversely affected by the regulation of Lake Winnipeg. Thus, in terms of the use of the facilities for importation or exportation of freight or as a means of inbound or outbound passenger travel, the effects of the regulation of Lake Winnipeg on transportation facilities and services will be minimal. Since the maximum mean monthly water level under regulated conditions will be 0.66 ft below the modified historic maximum mean monthly level, no damage to all-weather roads should result from hydro developments. Some isolated local connecting roads along the shore of the south basin of Lake Winnipeg which are close to the water's edge could experience flooding after regulation, resulting from a combination of high water levels and wind set-up. However, these roads usually experience such flooding during unregulated conditions. This type of flooding will be diminished after regulation due to lowering of the maximum water level.

Normal length of the navigation season on Lake Winnipeg is 5 months, from June to October. The navigation route used by the principal marine freight carriers extends from Winnipeg or Selkirk via the Red River to Matheson Island, Bloodvein, Berens River, Poplar River and points north on the Outlet Lakes (Fig. 5-10).

Regulation of Lake Winnipeg levels within the range of elevations 711 ft to 715 ft will not alter the route taken by the principal marine freight carriers since the regulated levels are well within the recorded elevations and as such will not affect the navigable depths of the lake.

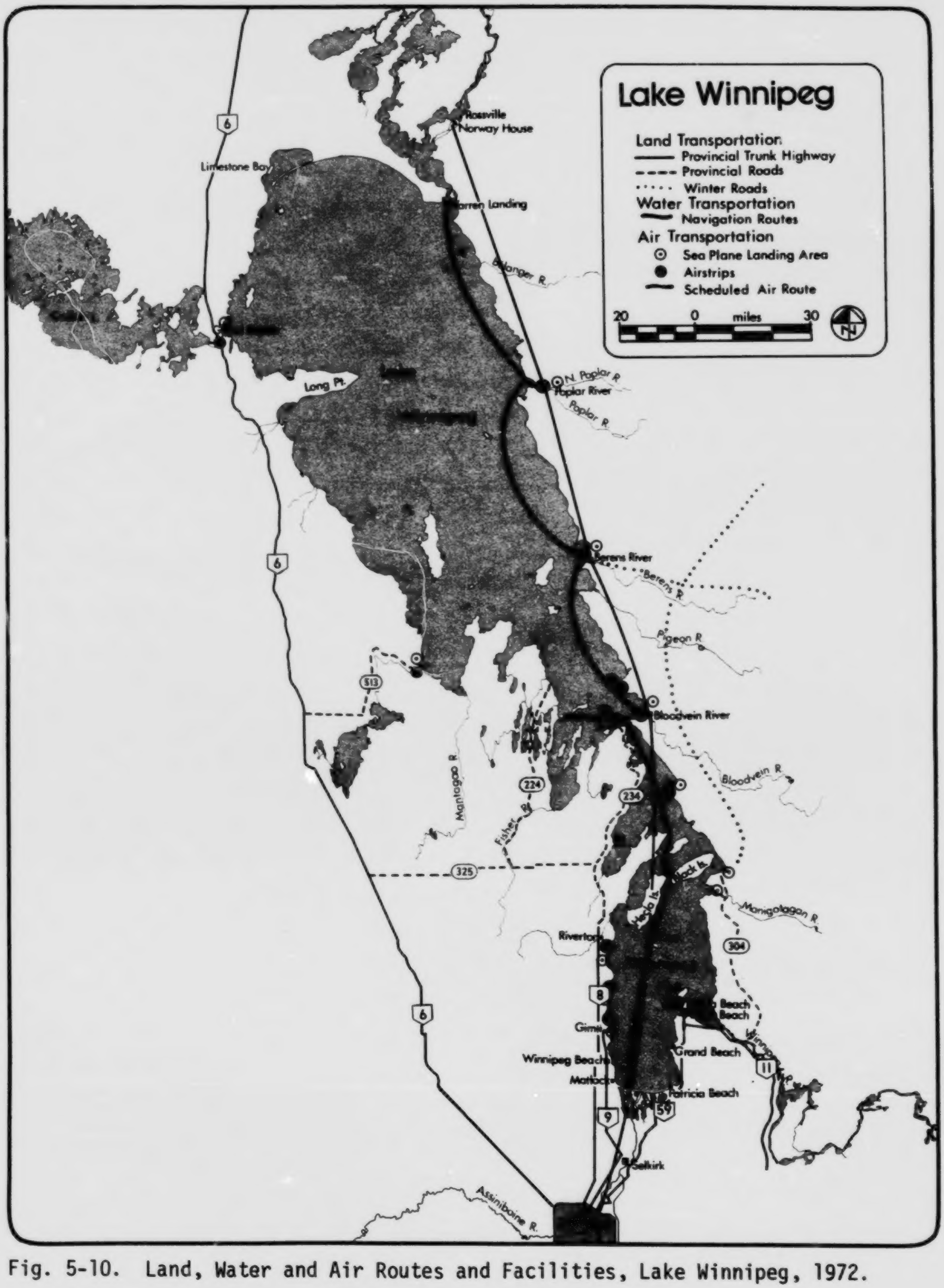

Lake Winnipeg
Land Transportation
Provincial Trunk Highway
Provincial Roads
Winter Roads
Water Transportation
Navigation Routes
Air Transportation
Sea Plane Landing Area
Airstrips
Scheduled Air Route
20
0
miles
30
N
Rossville
Norway House
Limestone Bay
Warren Landing
Belanger R.
N. Poplar R.
Poplar River
Poplar R.
Long Pt.
Berens River
Berens R.
Pigeon R.
Bloodvein River
Bloodvein R.
Mantagao R.
Fisher R.
Black Is.
Hecla Is.
Manigotagan R.
Riverton
Gimli
Winnipeg Beach
Matlock
Grand Beach
Patricia Beach
Selkirk
Winnipeg R.
Assiniboine R.
6
513
224
234
325
304
8
9
59
11

Fig. 5-10. Land, Water and Air Routes and Facilities, Lake Winnipeg, 1972.

Aids to navigation on inland waterways are constructed, maintained and repaired by the Marine Branch, Canada Department of Public Works. These aids are operated by the Canadian Ministry of Transport. Seventy-eight aids to navigation are in operation during the ice-free season on Lake Winnipeg. In addition to the navigational aids, several breakwaters have been constructed to protect various wharf facilities. These structures and their locations are listed in Table 5-5.

Marine freight handling facilities exist at the locations served by the major marine freight carriers: Matheson Island, Bloodvein, Berens River and Poplar River. Other wharfs exist at various locations on the lake to serve recreation boating and unscheduled freight handling. The elevations of the wharves at Matheson Island and Matheson Island Landing are above the maximum regulated level of 716.50 ft and the structures will not undergo flooding as a result of regulation. The deck elevation of the wharf at Bloodvein is well above present water levels and should not be affected. The deck elevation of the wharf at Berens River is 718 ft and the structure will incur no adverse effects as a result of hydro development. Similarly, the elevation of the deck of the wharf at Poplar River is such that it will be unaffected by regulation.

There are a number of public and private dock and wharf facilities on the Lake Winnipeg shoreline, especially in the south basin. The deck elevations of the wharves built by the Canada Department of Public Works for public use are all well above the maximum regulated level and thus should not be affected. The private and other public wharves should not be affected by lake regulation any more adversely than under unregulated conditions since unregulated levels have been as much as 0.66 ft higher and 1.43 ft lower than the regulated maximum and minimum levels respectively.

There are fifteen floatplane bases on or near Lake Winnipeg which are used by private individuals and charter services (Fig. 5-10). Several of the bases at present have areas of unmarked reefs. It is possible that in times of lower water under regulated conditions (less than 713 ft) these reefs may become dangerous since they will be closer to the lake surface. However, since unregulated levels have been as low as 709.67 ft, under regulated conditions the amount of exposure of the reefs could be less severe.

TABLE 5-5
DEPARTMENT OF PUBLIC WORKS MARINE STRUCTURES ON LAKE WINNIPEG

| LOCATION | STRUCTURE | DECK ELEVATION |
|---|---|---|
| Arnes | Wharf | 718.5 |
| Berens River | Wharf | 718.0 |
| Calder's | Wharf | 719.0 upper<br>717.0 lower |
| Gimli | Wharf | 719.2 |
| | Timber Breakwater | 717.0 |
| | Steel Breakwater | 718.0 |
| Grand Rapids | Wharf | 718.9 |
| Gull Harbour | Wharf | 718.0 |
| Hecla | Wharf | 718.5 |
| Hnausa | Wharf | 718.0 |
| | Breakwater | 720.0 |
| Matheson Island | Wharf | 719.0 upper<br>716.6 lower |
| Matheson Island Landing | Wharf | 717.5 |
| Matlock | Breakwater | 719.0 |
| McBeth Point | Wharf | 717.1 |
| Pine Dock | Wharf | 718.8 |
| Rabbit Point | Wharf | 718.0 |
| Riverton | Wharf | 717.0 |
| Red River Mouth | Wharf | 719.2 |
| | Training Walls | 716.0 |
| Selkirk (Red River) | Wharf | 720.0 |
| Selkirk Slough | D.P.W. Shipyard | 721.0 upper |
| | D.P.W. Wharf | 719.0 lower |
| Victoria Beach | Wharf | 720.0 |
| Winnipeg Beach | Breakwater | 723.0 |

SOURCE: *Canada Department of Public Works, Marine Branch, 1972.*

In 1973 there were eleven airstrips in the Lake Winnipeg area. Of this number, seven were Manitoba Government land aerodromes and the remainder privately owned. Although elevations are available for only the airstrips at Berens River (elevation 728 ft) and Poplar River (elevation 728 ft), it is reasonable to assume that none of the airstrips in the area will be adversely affected by Lake Winnipeg regulation. This assumption is based on the fact that none of the airstrips have been flooded or otherwise damaged under natural recorded lake levels.

A major winter road extending from Hole River to God's Lake Indian Reserve is located on the east side of Lake Winnipeg. Branches of this main winter road serve the communities of Berens River and Bloodvein on Lake Winnipeg. These branch winter roads will not be adversely affected by lake regulation. Their routes do not lie to any extent on the ice of Lake Winnipeg and therefore the roads will not be affected by possible alterations in ice formation as a result of the regulation project.

Both Canadian National and Canadian Pacific railways operate branch lines in the area. The Canadian Pacific line runs north on the west shore of Lake Winnipeg from Winnipeg to Riverton. The Canadian National line runs northeast from Winnipeg to Beaconia and Pine Falls. The location of both rail lines is such that they are well above the maximum elevation of the lake under regulated conditions (716.50 ft) and thus will remain unaffected by regulation.

At present navigation is possible from St. Norbert, via the St. Andrews lock, along the Red River to Lake Winnipeg and as far north as Whiskey Jack Landing on the northeast end of Kiskittogisu Lake or as far as Jenpeg if required. Most marine freight destined for communities on Lake Winnipeg and the Outlet Lakes is shipped from Selkirk (downstream of the St. Andrews lock) or Winnipeg.

Average lake depth varies from 15 ft at the extreme southern end to 80 ft in the northern basin. Shipping on the lake is governed by the minimum navigable depth of the channel through the Red River delta which is dredged to a dredge grade line of elevation 700.0 ft.

# EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON COMMUNITIES ON LAKE WINNIPEG

As noted earlier, the socioeconomic effects of the regulation project on communities on Lake Winnipeg were not examined. However, investigations into the effects of the regulation of Lake Winnipeg on structures along the shoreline of Lake Winnipeg were undertaken. The effects of water regime changes on the dykes on the south basin of Lake Winnipeg were investigated. Studies were also conducted to determine if the water regime changes would cause ice regime changes, and whether these changes would increase or decrease the amount of damage done by ice to structures along the lakeshore.

## COMMUNITY INFRASTRUCTURE

DYKES AROUND THE SOUTH BASIN - Property damage results when Lake Winnipeg levels rise above elevation 717.0 ft. In 1950, when a peak daily level of 718.5 ft was reached at Gimli, $1,200,000 in damages resulted and in 1966 damage reached $1,800,000 when the peak daily level rose to 719.0 ft. After the flooding that occurred in 1966, dykes were constructed by the Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management, in some areas adjacent to the lake. These dykes were raised and extended in 1970 (Fig. 5-11). In anticipation of high water in 1974, an additional dyking program was undertaken around the communities and cottage areas. The dykes mainly protect agricultural land from flooding although there is some dyking at Grand Beach, Gimli and Riverton which protects urban property. The provincial government has purchased some property between the dykes and the lake and also some land behind the dykes.

The dykes are considered to be of a temporary nature as they were mainly constructed using dragline cranes with little or no control as to selection and compaction of materials. Dyke top elevations are generally satisfactory for flood control purposes. Pumps are located landward of these dykes for pumping runoff over the dykes when high levels on the lake prohibit gravity drainage by means of gated culverts through the dykes. These pumps can be supplemented by auxiliary pumps if the need arises.

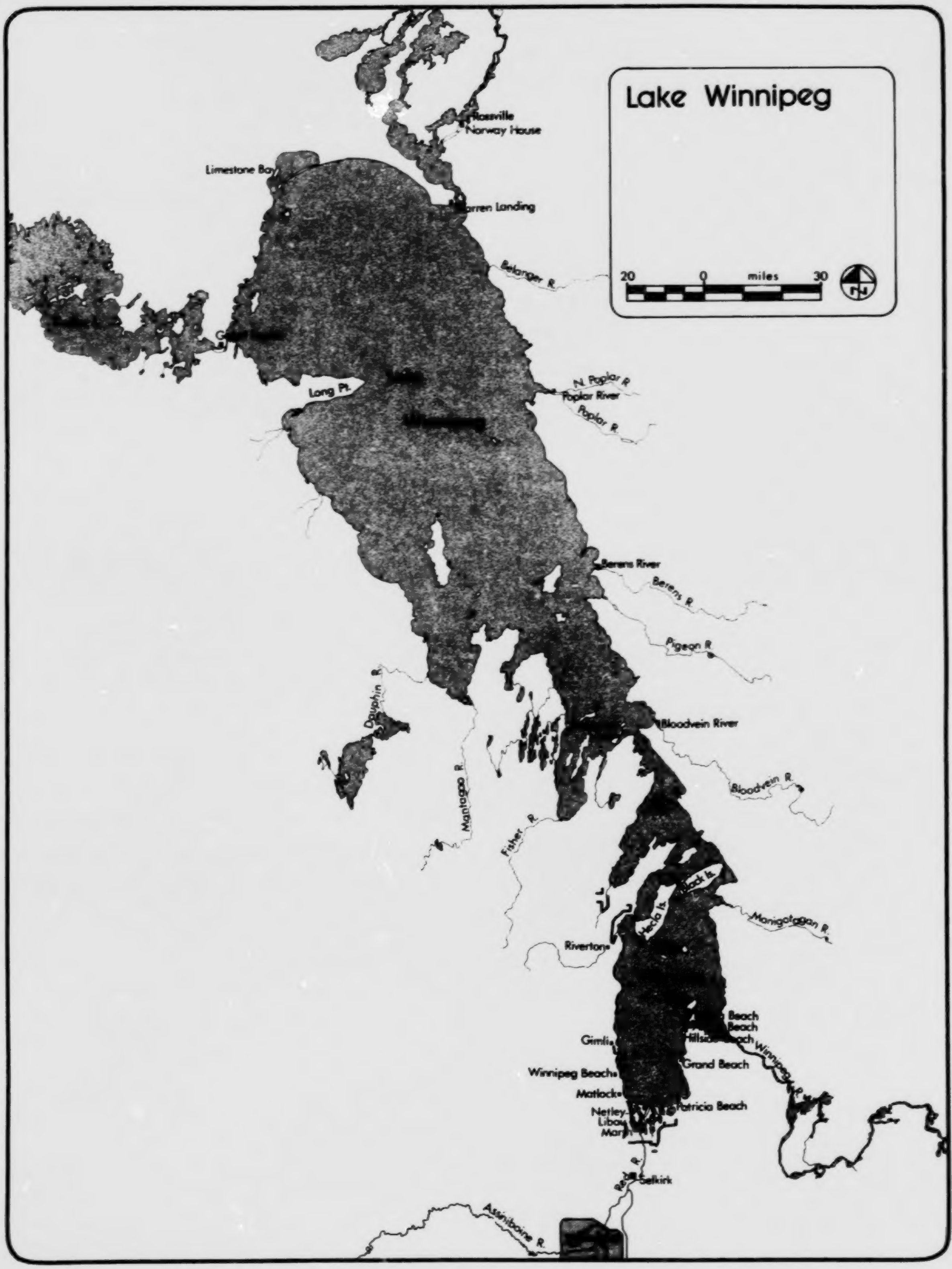

Lake Winnipeg
20
0
miles
30
Rossville
Norway House
Limestone Bay
Warren Landing
Belanger R.
Long Pt.
N. Poplar R.
Poplar River
Poplar R.
Berens River
Berens R.
Pigeon R.
Dauphin R.
Bloodvein River
Bloodvein R.
Mantagao R.
Fisher R.
Black Is.
Hecla Is.
Manigotagan R.
Riverton
Beach
Beach
Hillside Beach
Gimli
Grand Beach
Winnipeg Beach
Winnipeg R.
Matlock
Patricia Beach
Netley
Libau
Marsh
Selkirk
Red R.
Assiniboine R.

Fig. 5-11. Location of Dykes Around the South Basin of Lake Winnipeg, 1973.

The base of the dykes is between elevation 716 ft and 718 ft with an average embankment height of 5 to 6 ft, and a top width varying from 8 to 15 ft. The dyking system is almost 50 miles long and consists of six main sections (Table 5-6) which protect about 19,000 acres of land below elevation 722 ft.

TABLE 5-6
LAKE WINNIPEG TEMPORARY DYKING SYSTEM
SUMMARY TABLE

| Location | Approximate Top of Dyke Elev. (G.S. of C.) (Ft.) | Approximate Length of Dyke (Miles) | Total Acreage Protected to 722' (Acres) | Acreage Protected (Acres) | | | Cropland (Acres) | Improved Pasture (Acres) | Native Grazing (Acres) | Woodlot Pasture (Acres) | Land Value Range | | Estimated Net Annual Income ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Elev. 716' to 718' | Elev. 718' to 720' | Elev. 720' to 722' | | | | | Low ($) | High ($) | |
| Washow Bay Area | 722-3 | 7.5 | 2,740 | 500 | 1,510 | 730 | 1,070 | 660 | 500 | 460 | 108,800 | 145,700 | 24,500 |
| Riverton and North Area | 722-3 | 16.9 | 12,360 | 1,970 | 5,710 | 4,680 | 5,800 | 2,220 | 880 | 3,460 | 551,800 | 709,800 | 115,200 |
| Arnason's Dyke | 723 | 2.7 | 510[1] | 330 | 130 | 50 | 20 | 50 | 330 | 10 | 6,000 | 10,450 | 2,400 |
| Petersfield | 723 | 3.5 | 880 | 420 | 250 | 210 | 440 | 180 | 170 | 90 | 41,400 | 54,600 | 8,900 |
| Libau Area | 720-1 | 15.5[2] | 1,710 | 240 | 600 | 870 | 720 | 530 | 260 | 200 | 72,700 | 97,720 | 16,480 |
| Ducks Unlimited Dyke and P.R.320 | 723 & 721 | 3.7[3] | 1,110 | 600 | 510 | -[4] | 290 | 150 | 400 | 270 | 32,900 | 44,950 | 7,690 |
| TOTALS | | 49.8 | 19,310 | 4,060 | 8,710 | 6,540 | 8,340 | 3,790 | 2,590 | 4,490 | 813,600 | 1,063,220 | 174,810 |

*Note:*
1. *Includes a 100 acre sewage treatment facility.*
2. *Total line of defense along road allowances.*
3. *Includes 0.6 miles of P.R. 320 considered as dyke.*
4. *Information not available.*

EFFECT ON DYKES AROUND THE SOUTH BASIN - A study was undertaken by the Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management, on behalf of the Study Board, to determine the mean annual erosion damages to the dyking system due to the extended duration of high lake levels. To evaluate the effect of regulation on dyke maintenance costs, damages were computed for both unregulated and regulated conditions. Data on the costs of pumping, dyke construction and maintenance were collected over the period 1966-71. The actual costs over this 5 year period for pumping, dyke construction and maintenance were used to calculate the mean cost and to predict future maintenance costs. The mean annual cost of maintenance was correlated with water levels and the period of time during which high lake levels were anticipated to occur under unregulated and regulated conditions.

The study computed mean annual dyke damages to be $16,800 under unregulated conditions and $19,400 under regulated conditions. It is, therefore, anticipated that due to increased mean water levels with regulation, the annual costs of dyke maintenance will be $2,600 higher, assuming prices remain constant.

However, the cost of pumping runoff over the dykes, when conditions are such that high levels on the lake prohibit gravity drainage, is anticipated to be less under regulated conditions. The mean annual cost of pumping under unregulated conditions was estimated to be $4,700 based on costs over the period 1966-71 and assuming prices remain constant. With regulation, mean annual pumping costs are anticipated to be $1,600 based on the same set of assumptions. Total mean annual costs for maintaining the dykes under unregulated conditions were $21,500 as compared to $21,000 with regulation.

The probability of dyke failure and water flowing over the top of dykes, due to high lake levels and wind set-up, was also examined in this study. The probability of dyke failure under unregulated and regulated conditions was estimated by comparing the maximum annual daily lake levels and the probability of their occurrence under unregulated and regulated conditions. Investigations indicated that under regulated conditions, levels below elevation 719 ft have a greater probability of occurrence and lake levels above elevation 719 ft have a smaller probability of occurrence than under unregulated conditions. If it is assumed that dykes will fail at elevations exceeding 719 ft, then regulation will decrease the probability of dyke failure and of water flowing over dykes along the southern basin.

OTHER STRUCTURES ON THE SOUTH BASIN - In addition to the dyking system, shoreline property along Lake Winnipeg includes homes, cottages, docks and piers. No study of the effects of regulation on these properties was undertaken by the Study Board. Although the long-term mean level of Lake Winnipeg will be slightly higher (0.66 ft) with regulation, the range between maximum and minimum levels is anticipated to be within the unregulated range. It can be concluded that with regulation there will not be any inundation of shoreline property that was not inundated prior to regulation. Therefore, it is anticipated that there would be no change in the extent of flooding of shoreline property after regulation.

Analytical computations and a survey of lakeshore residents indicated that shoreline damage due to ice effects under unregulated conditions is uncommon and requires an unusual combination of circumstances. The lack of damage is partly attributable to the fact that people do not construct light docks and boat houses which would be damaged.

Under unregulated conditions, ice damage on Lake Winnipeg may occur during three periods: November-December freezeup period; early April period; and late April breakup period. During the November-December freezeup period ice damage may occur due to the lateral movement of ice onto the shore caused by the expansion of the ice cover. In early April, following the melting of snow cover, damage can be caused by ice shove due to the expansion of the ice cover during the early melting period. During the candled-ice stage of melting in late April, the piling up of ice along the shore during periods of strong winds may also cause damage to property.

Excessive lateral movement of the ice sheet during the above periods may shift beach material and destroy shoreline vegetation and structures in the movement zone. Damage to submerged structures such as piers, footings and docks, due to vertical movements of the ice sheet corresponding to winter water level fluctuations, may also occur.

The conclusions derived from the field evidence concur with those derived from analytical computations and may be summarized as follows:

- The lateral movement of the ice due to the thermal expansion of the ice sheet does not cause significant damage.
- During the spring breakup period, the piling up of ice due to wind forces is common. However, ice pile up normally occurs offshore or on the beach and does not damage buildings or trees.
- High mounds of piled up ice are normally associated with wind acting on a wide ice sheet pushing against a narrower structure or shoreline.
- Damage to shoreline buildings appears to have a frequency of once or less in a lifetime and depends on a rare combination of high onshore winds (greater than 30 miles per hour) from a narrow sector (within a 45° angle) during a short interval of time (2 weeks) together with the multiplier effect on a long ice sheet acting on a short shoreline. In addition, the water level must be sufficiently high so that the ice piles up near enough to the shoreline to damage shore structures.
- The lower spring lake levels in comparison to the fall lake levels result in reduced onshore ice pile up and reduced damage to beaches and beach works.

EFFECT ON OTHER STRUCTURES ON THE SOUTH BASIN - It is anticipated that regulation may cause a minor change in the ice regime of Lake Winnipeg. However, if in fact any change occurs it will be small. Therefore, because damage to structures is minor under unregulated conditions, the effect of the regulation project may be a minor change in the amount of damage to structures by ice.

# SUGGESTED MEASURES FOR THE LAKE WINNIPEG AREA TO ENHANCE THE BENEFITS OF THE LAKE WINNIPEG REGULATION PROJECT

During the course of their investigations on Lake Winnipeg, contracting agencies suggested ways to enhance the overall benefits of the Lake Winnipeg regulation project. However, time and funding constraints prohibited investigating these suggestions in detail. The measures that were suggested are presented in Table 5-7. This will serve as a rough guide to those responsible for examining enhancement measures.

TABLE 5-7
SUGGESTED MEASURES FOR THE LAKE WINNIPEG AREA
TO ENHANCE THE BENEFITS OF THE LAKE WINNIPEG REGULATION PROJECT

| | ● Fish Populations | ○ Efficiency of Harvesting | ● Wildlife Populations | ○ Efficiency of Harvesting | ● Forest Resources | ○ Utilization of Forest Resources | ● Mineral Resources | ○ Utilization of Mineral Resources | ● Outdoor Recreation Resources | ○ Utilication of Outdoor Recreation Resources | ● Knowledge of Prehistorical and Historical Cultures | ● Transportation-Navigation services and facilities. | ○ Utilization of Trans-Navigation services and facilities. | ● Community Infrastructure on Lake Winnipeg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A land use and development plan for the south basin of Lake Winnipeg be formulated and implemented. | | | | | | | | | | E | | | | |
| Several small beaches be constructed by importing sand and these beaches be protected by groin type structures. | | | | | | | | | E | | | | | |
| A Lake Winnipeg Shoreline Handbook be published and distributed. | | | | | | | | | | E | | | | E |
| Construct a lined boat channel through the opening in the sand bar between Victoria Beach and Hillside Beach. | | | | | | | | | | E | | | | |
| Major marshes such as Netley-Libau should be managed. | | | E | | | | | | | E | | | | |
| Dykes should be constructed on some lakes of the Netley-Libau marsh. | | | E | | | | | | | E | | | | |
| Pothole Blasting, island construction and planting of attractive food species should be carried out in major marshes. | | | E | | | | | | | E | | | | |
| Specific areas around Lake Winnipeg should be managed for Canada geese. | | | E | | | | | | | E | | | | |

LEGEND

E The suggested measure has the potential to increase the factor to a state greater than it was prior to the Regulation of Lake Winnipeg.

# FOOTNOTES

[5-1] The Saskatchewan-Nelson Basin Board was established in 1968 under an agreement among the governments of Canada, Manitoba, Saskatchewan and Alberta to study the water resources of the three prairie provinces. The Board submitted a final report in 1972.

[5-2] R. E. Hecky and H. A. Ayles. "Summary of Fisheries Limnology Investigations on the lower Churchill Lakes and on the Rat-Burntwood Lakes", Fisheries and Marine Service, Environment Canada, Winnipeg, Manitoba, 1974, p.1.

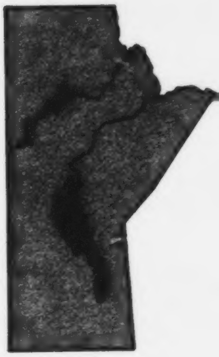
[5-3] Ibid, p.1.

[5-4] Province of Manitoba, Manitoba Department of Mines, Resources and Environmental Management and Manitoba Hydro "Program for Regulation of Lake Winnipeg", January, 1972, Summary Statement p.8.

[5-5] Ibid, Part II, pp. 12,19.

[5-6] Ibid, Part II, p.32.

[5-7] Azman Azis, George S. Barry and Ian Haugh. "The Undiscovered Mineral Endownment of The Canadian Shield of Manitoba", Mineral Bulletin MR 124, Mineral Resources Branch, Department of Energy, Mines and Resources, Ottawa, Pulibcation 72-1, Mines Branch, Department of Mines, Resources and Environmental Management, Manitoba, Information Canada, Ottawa, 1972.



# chapter 6

# area 2
outlet lakes

## GEOGRAPHY

### LOCATION

The Outlet Lakes, for purposes of this study, have been defined as that portion of the upper Nelson River comprising the East and West channels of the Nelson River, and Playgreen, Little Playgreen, Pipestone, Kiskittogisu, Kiskitto and Cross lakes (Fig. 6-1). The upper Nelson River and lakes downstream from Cross Lake were not studied. These lakes, particularly Sipiwesk Lake, have already been substantially affected by the construction and operation of the Kelsey generating station, and it is anticipated that further changes due to operation of the Lake Winnipeg regulation works will be minimal. Water levels on Sipiwesk Lake are controlled by the Kelsey generating station and to a lesser degree, in the future, by the regulation of Lake Winnipeg.

### CLIMATE

The climate of the area is characterized by a relatively short, cool growing season, long cold winters, and moderate precipitation. The mean annual temperature is 28.9°F, as determined from the meteorological records of two stations, Norway House and Wabowden. Mean monthly temperatures range from -10°F in January to 64°F in July. The frost free period ranges from 90 to 100 days. Annual precipitation averages 18 inches of which about 60 percent falls as rain during the period April to October.

Fig. 6-1. Satellite Photograph of the Outlet Lakes, September, 1973.

## PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL

Most of the upper Nelson River area is part of the Severn Upland assigned to the Superior Province of the Precambrian shield physiographic region. The south-western portion of this area extends to the northern edge of the Manitoba lowlands but only a little of it lies within this physiographic region.

Topography reflects the influence of bedrock configuration and its geomorphic history, particularly that of glacial and post-glacial periods. Relief is moderate to slight with elevations ranging between 650 and 800 ft above sea level. Outcrops of Precambrian bedrock, often exposed but sometimes covered with mineral soil, present a hilly relief on a local scale. Other minor relief features include modified eskers and beaches on the crests of end moraines, usually buried under peat accumulations.

The present distribution of surface material has been influenced by glaciation during the Wisconsin ice age. Organic deposits, glacial till, lacustrine clays and glaciofluvial sands comprise the surficial material. Following the retreat of the ice, the region was covered by glacial Lake Agassiz. Today, unmodified Lake Agassiz sediments are the dominant deposit in the Outlet Lakes area. The lacustrine sediments are primarily clay in texture and are highly calcareous. The surface sediments are homogeneous and sparingly stony; they are often underlain by varved clays which contain a few rafted stones. Laminated lacustrine deposits are present in small pockets at higher elevations. Organic deposits are very prominent in the area. They are the result of vegetal debris accumulating in poorly drained locations.

Other locally significant Lake Agassiz sediments are the beaches. Their occurrence tends to be restricted to the crest of the two end moraines. They consist of very highly calcareous silt and moderately calcareous sand.

## VEGETATION

The upper Nelson River area lies within the Boreal Forest region. Southern and western parts of this area are within the Manitoba lowlands forest region.

Black spruce (*Picea mariana*) and tamarack (*Larix laricina*) dominate most forest communities. Occurring with less frequency are jack pine (*Pinus banksiana*), trembling aspen (*Populus tremuloides*), white spruce (*Picea glauca*), balsam poplar (*Populus balsamifera*), balsam fir (*Abies balsamea*), white birch (*Betula papyrifera*) and alder (*Alnus* sp.).

On most sites black spruce forms climax stands with an understory of feather mosses. Typical black spruce and feather moss communities can occur on poorly drained organic soils as well as better drained clays, tills, sands and gravels. This is characteristic of about 90 percent of the area. Along lakes and rivers mixed stands of black and white spruce are common.

Jack pine stands are successional communities, usually formed after fires. Such stands are most common on better drained soils where repeated fires maintain the successional status. In areas of moist lacustrine clays, clay tills and alluvial or glaciofluvial sands, successional stands produced by fire, may include trembling aspen and balsam poplar as well as jack pine. The understory is characteristically more diverse, especially in the shrub and herb layers. This type of mixed forest exists over 10 to 35 percent of the Outlet Lakes area.

The vegetation of wet or saturated sites (organic soils) is influenced by fluctuations of ground water levels and flows, nutrients, precipitation and drainage. Willow (*Salix* sp.), alder and sedge (*Carex* sp.) communities develop on sites which have flowing or fluctuating water, and are well supplied with nutrients.

Marsh vegetation in the Outlet Lakes area is characterized by a band of sedge along the margin of the wet ground in 0 to 1 ft of water with an outer band of bulrush (*Scirpus* spp.) in 1 to 5 ft of water. Pond (*Potamogeton* spp.) and duckweed (*Lemna* sp.) occur as either submergent or floating members of more extensive communities. Duckweed may occur on the surface in various depths where there is no movement to the water.

Marshes only develop where there are shallow, protected waters with a suitable substratum for rooting.

## DRAINAGE PATTERNS

Water, collected in a drainage basin of 380,000 square miles extending west to the Rocky Mountains, south to the headwaters of the Mississippi River and east to Lake Superior, flows through Lake Winnipeg and discharges into the Nelson River system at Warren Landing. From this point the flow is directly into the south basin of Playgreen Lake. From Playgreen Lake, approximately 15 to 20 percent of the flow is through Little Playgreen Lake, to the East Channel of the Nelson River and Pipestone Lake and then into Cross Lake. The remaining 80 to 85 percent flows through Playgreen Lake to Whiskey Jack Narrows and into Kiskittogisu Lake. From Kiskittogisu Lake the flow is via three channels (Kisipachewuk, Metchanais and Ominawin) to Kiskitto Lake thence to the West

Channel and Cross Lake to join waters arriving by the eastern route (Fig. 6-2).

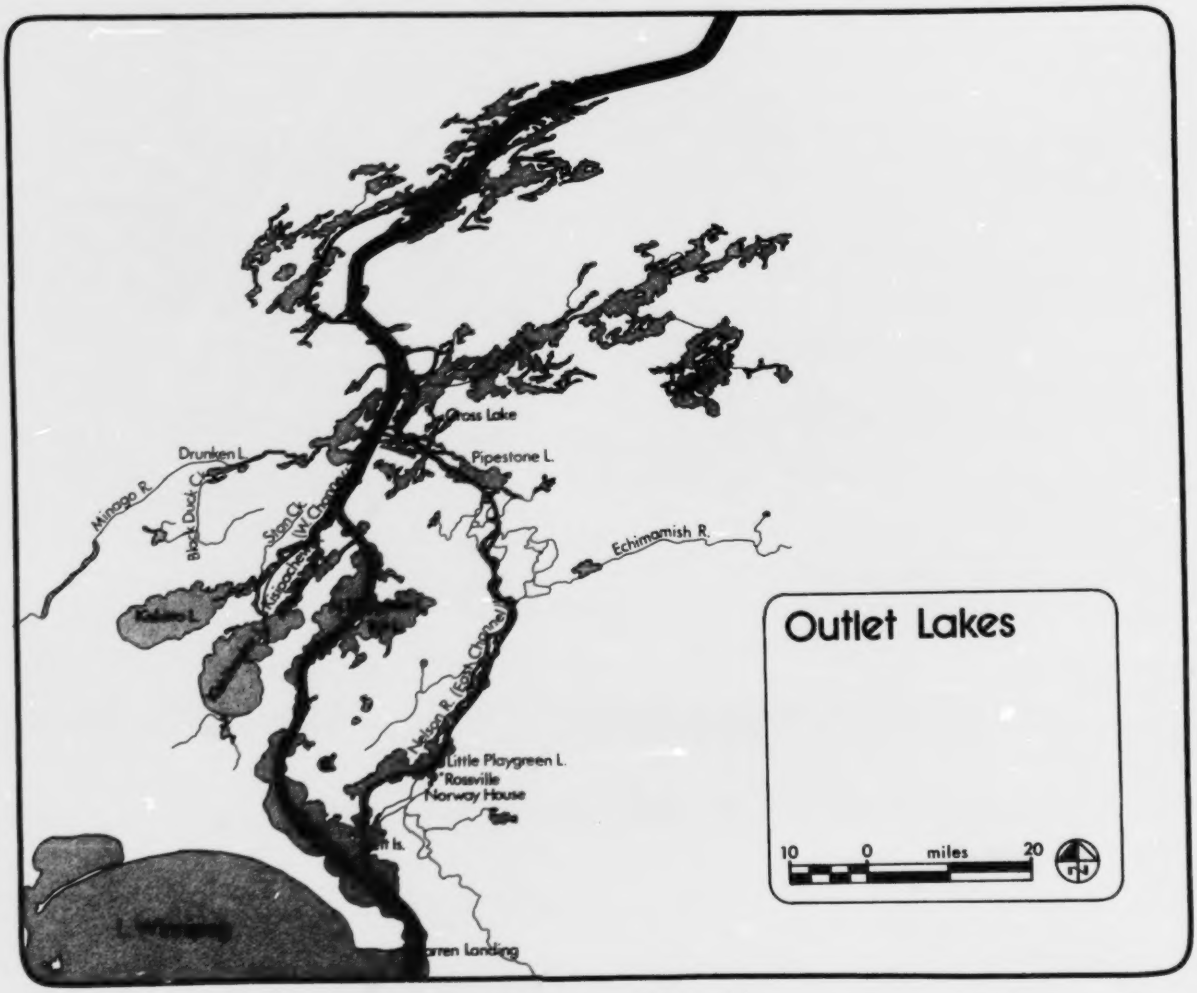

Outlet Lakes
Cross Lake
Pipestone L.
Drunken L.
Minago R.
Black Duck Cr.
Stan Cr.
(W. Channel)
Echimamish R.
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
it Is.
arren Landing
10
0
miles
20

Fig. 6-2. Drainage Pattern of the Upper Nelson River.

## HUMAN HABITATION

There are three permanent communities in the Outlet Lakes area: Cross Lake; Norway House-Rossville; and Warren Landing. The people in the area number approximately 5000; the majority reside in either Cross Lake or Norway House-Rossville.

The community of Cross Lake is scattered along 5 miles of the southeast shore of Cross Lake. Its population is approximately 2000 permanent residents of which 1770 are Registered Indians and the remaining 230 are Non-Registered Indians.

The community of Norway House-Rossville is located on the East Channel of the Nelson River approximately 18 miles north of the natural outlet of Lake Winnipeg. The population is approximately 3000 of which approximately 67 percent are Registered Cree Indians. The remainder are Non-Registered Indians except for a small group of transient professional persons, mainly in the media, health and educational fields.

No 1971 census estimates are available for Warren Landing, at the natural outlet of Lake Winnipeg, but the Canada Department of Regional Economic Expansion has estimated the population to be twenty-seven.

Prior to 1971, access to the area was restricted primarily to air and water transportation. Construction of Provincial Trunk Highway 6, on the western periphery, has provided the only paved all-weather road in the Outlet Lakes area. This highway extends from Winnipeg to Ponton approximately 364 miles to the north, where it intersects with Provincial Road 391. Provincial Road 391, and Provincial Road 373, which extends 19.4 miles from Provincial Road 391 to Sipiwesk Lake, are all-weather gravel surfaced roads (Fig. 6-3).

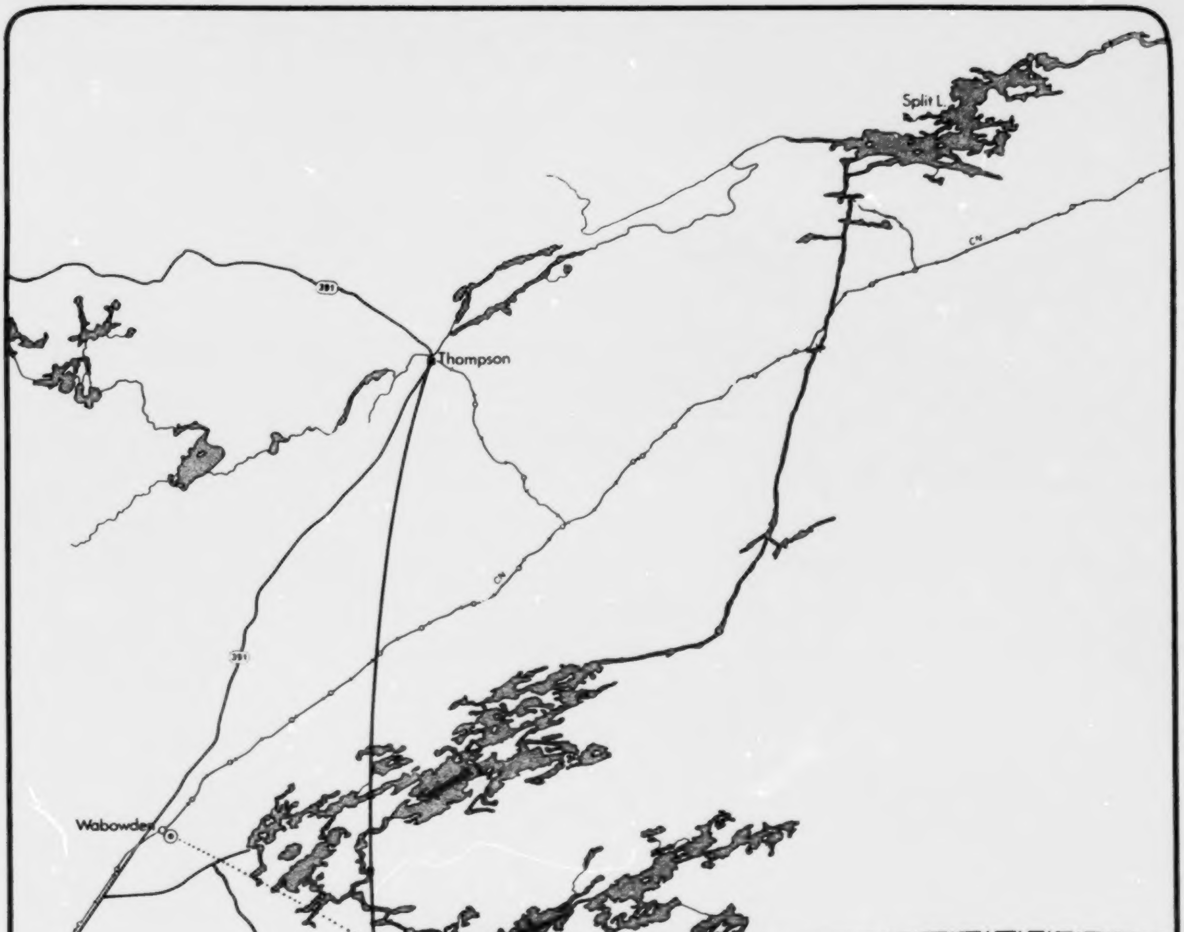

Split L.
Thompson
391
CN
Wabowden
Cross Lake
Drunken L.
Pipestone L.
Minago R.
Black Duck Ck.
Stan Ck.
Echimamish R.
Little Playgreen L.
Norway House
Outlet Lakes
Land Transportation
Railway
Provincial Roads
Roads Built by Manitoba Hydro
Jenpeg - Norway House (Proposed)
Jenpeg - Cross L. (Proposed - Alt. 1)
Jenpeg - Cross L. (Proposed - Alt. 2)
Water Transportation
Major Navigation Route
Docking Facility
Warehousing & Docking Facility
Air Transportation
Gravel Airstrips
Clay Airstrips
Emergency Landing Strips
Sea Plane Landing Areas
Commercial Air Routes
10
0
miles
20

Fig. 6-3. Land, Water and Air Transportation Services and Facilities, Outlet Lakes, 1973.

# EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE PHYSICAL ENVIRONMENT

## WATER REGIME CHANGES

The regulation of Lake Winnipeg will alter the water regime of the Outlet Lakes. Changes will occur in the rate of flow through the East and West channels of the Nelson River, and in the surface water levels of Playgreen, Kiskittogisu, Kiskitto and Cross lakes. These have been identified and are presented in the following section.

The mean monthly modified historic water levels for, and discharges from, Lake Winnipeg, and mean monthly modified historic levels for Cross Lake, which had been computed by the Saskatchewan-Nelson Basin Board[6-1] in 1972 formed part of the base data for these investigations. The remainder was supplied by Manitoba Hydro who prepared the hydraulic energy loss curves for the Outlet Lakes and the regulated discharge data for Lake Winnipeg. This information was used by the Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management, to calculate the water regime for Playgreen, Kiskittogisu and Cross lakes under regulated and unregulated conditions. Manitoba Hydro also prepared the water regime data for Kiskitto Lake under regulated and unregulated conditions.

EAST AND WEST CHANNELS - Discharges for the East and West channels under regulated and unregulated conditions are shown in Table 6-1.

With regulation, the minimum mean monthly and average mean monthly discharges through the East Channel will increase, and the maximum mean monthly discharges will decrease. In contrast, the minimum mean monthly and average mean monthly discharges through the West Channel will decrease under regulation, while the maximum mean monthly discharges will increase.

The seasonal fluctuations of discharges are depicted in Fig. 6-4 and 6-5. Under unregulated conditions, the average mean monthly flows in both the East and West channels would increase in May, peak in June and July, and begin to decline in August. With regulation, it is anticipated that average mean monthly flows in the East Channel will increase in May, peak in August, and then decline in the following months. In the West Channel, it is anticipated that average mean monthly discharges will begin to increase in November, peak in January, and then decline until April, subsequently reaching a spring runoff peak in June.

KISKITTOGISU AND PLAYGREEN LAKES - With regulation, Playgreen Lake will also discharge through the 8-Mile Channel into Kiskittogisu Lake, and the north basin of Playgreen and Kiskittogisu lakes will have similar water regimes. The net effect on Kiskittogisu and Playgreen lakes will be to raise average annual mean monthly levels and to reduce the range between maximum and minimum mean monthly water levels (Table 6-2). The rise in average mean monthly water levels will be greatest near the control structure at Jenpeg. The average level of Kiskittogisu Lake will increase by 2.6 ft, while the average level of the south basin of Playgreen Lake will only increase by 1.5 ft.

As depicted in Figs. 6-6,6-7 and 6-8, average mean monthly levels on Playgreen and Kiskittogisu lakes with regulation will be higher for all months of the year than under unregulated conditions. Regulated minimum mean monthly water levels on these lakes will be higher for each month of the year than under unregulated conditions. Regulated maximum mean monthly levels on these lakes will also be higher in every month than under unregulated conditions (except for the months of June and July in the south basin of Playgreen Lake).

TABLE 6-1
EAST AND WEST CHANNELS MEAN MONTHLY FLOWS

| Flows | Regulated | Unregulated | Change |
|---|---|---|---|
| East Channel | | | |
| Maximum | 24,600 cfs | 31,100 cfs | -6,500 cfs |
| Average | 14,600 | 8,900 | +5,700 |
| Minimum | 700 | 200 | +500 |
| West Channel | | | |
| Maximum | 158,700 cfs | 112,900 cfs | +45,800 cfs |
| Average | 55,200 | 60,900 | -5,700 |
| Minimum | 2,400 | 16,100 | -13,700 |

NOTE: *Based on modified historic data for the period 1928-66.*

TABLE 6-2
KISKITTOGISU AND PLAYGREEN LAKES MEAN MONTHLY WATER LEVELS

| Water Level | Regulated | Unregulated | Change |
|---|---|---|---|
| South Basin of Playgreen Lake | | | |
| Maximum | 715.4 ft | 715.9 ft | -0.5 ft |
| Average | 713.4 | 711.9 | +1.5 |
| Minimum | 710.1 | 707.0 | +3.1 |
| Range | 5.3 | 8.9 | -3.6 |
| North Basin of Playgreen Lake | | | |
| Maximum | 714.9 ft | 714.7 ft | +0.2 ft |
| Average | 712.6 | 710.5 | +2.1 |
| Minimum | 707.3 | 703.6 | +3.4 |
| Range | 7.6 | 11.2 | -3.6 |
| Kiskittogisu Lake | | | |
| Maximum | 714.5 ft | 712.8 ft | +1.7 ft |
| Average | 712.3 | 709.7 | +2.6 |
| Minimum | 706.6 | 703.6 | +3.0 |
| Range | 7.9 | 9.2 | -1.3 |

*NOTE: Based on modified historic data for the period 1928-66.*

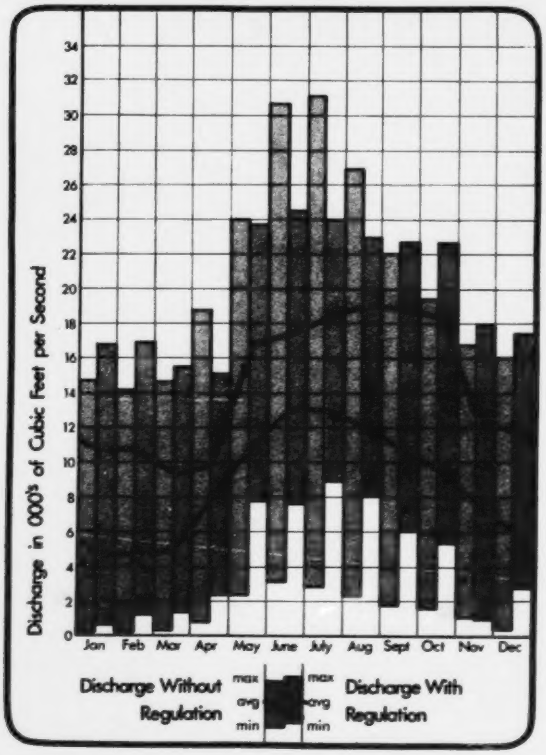


Fig. 6-4.
East Channel Discharges

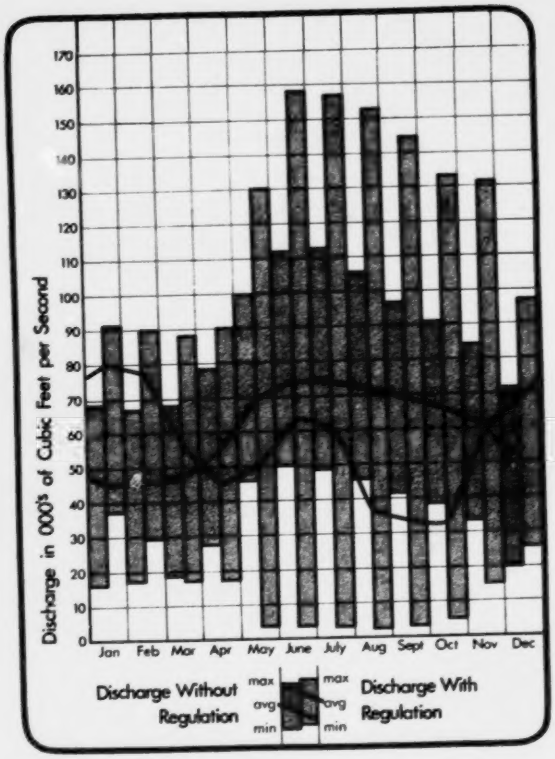


Fig. 6-5. West Channel Discharges

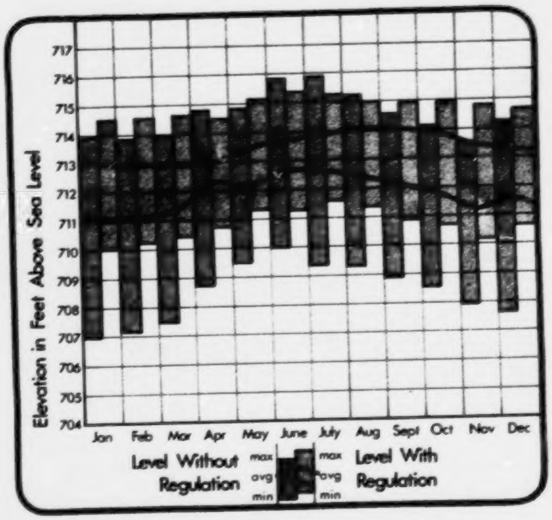


Fig. 6-6. Playgreen Lake (South Basin) Water Levels

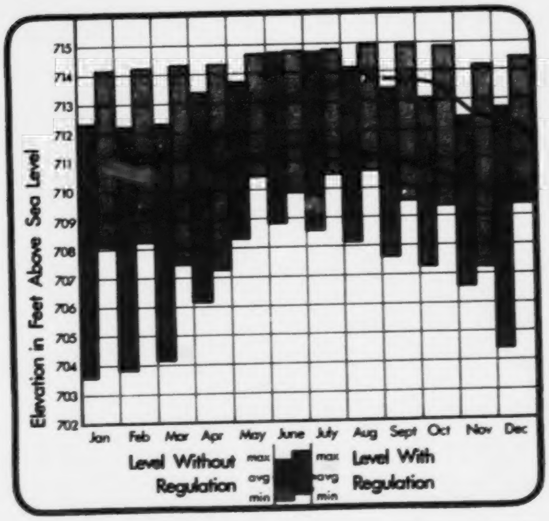


Fig. 6-7. Playgreen Lake (North Basin) Water Levels

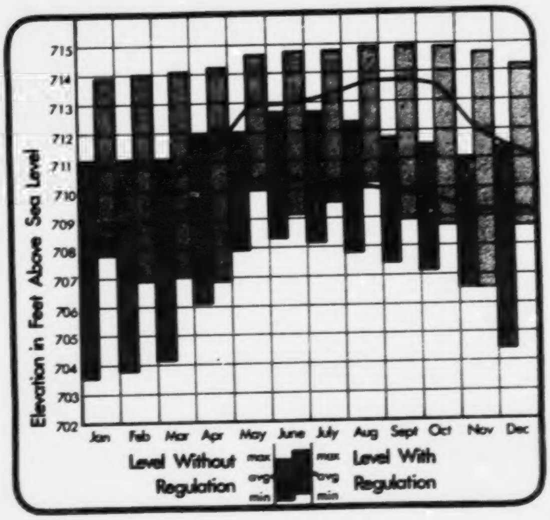


Fig. 6-8. Kiskittogisu Lake Water Levels

Under unregulated conditions, average mean monthly levels on Playgreen and Kiskittogisu lakes are high in summer, peaking in June and July, and low in winter, reaching their lowest levels in January and February. With the regulation of discharges from Lake Winnipeg this pattern will change. The average mean monthly water levels will peak in late summer, between August and October, and will decrease to a low in March.

The largest average mean monthly fluctuations under unregulated conditions on Kiskittogisu Lake occur between March and April when water levels increase on average by 0.9 ft. Under regulated conditions, it is anticipated that the largest average mean monthly fluctuations will occur on Kiskittogisu Lake when the lake level drops 1.7 ft between October and November, and March and April when it rises 1.7 ft.

KISKITTO LAKE - In the unregulated state variations in water levels on Kiskitto Lake are primarily dependent on variations in flows in the West Channel which in turn, are dependent upon Lake Winnipeg elevations. The drainage basin of Kiskitto Lake is small relative to its storage and natural outflow capacity. Therefore, variations in local inflow have a negligible effect on lake levels.

The control works at Jenpeg will be operated so as to ensure that the maximum water level in the West Channel does not exceed elevation 715 ft. Since large areas around Kiskitto Lake are between elevations 700 ft and 710 ft , extensive dyking would have been necessary to prevent the water in the West Channel from bypassing the control works at Jenpeg. Because of the high cost of such dyking, Manitoba Hydro proposed a scheme to isolate the lake from the West Channel. This proposal involved a dam and associated dykes to close Kiskitto Lake's natural outlet to the West Channel. In addition, this proposal required a rock weir at the new outlet and a drainage channel to convey the flow from the new outlet into Black Duck Creek and the Minago River system.

The changes in the water regime that this proposal would cause are shown in Table 6-3. In general, regulation of Kiskitto Lake under the proposal would result in higher average mean monthly water levels and a reduction in the range of water level fluctuations. Specifically, the average annual mean monthly lake level would be raised by 3.6 ft. Minimum mean monthly levels would increase under regulation by 8.6 ft; from 686.6 ft to 695.2 ft. Maximum mean monthly levels would drop 3.7 ft; decreasing from 702.0 ft to 698.3 ft. These changes would result in a reduction in the range of level fluctuations from 15.4 ft in the unregulated state to 3.1 ft in the regulated state.

Investigations into the effects of these changes in the water regime led to a modification in the design plans. The findings of these investigations are reported by the Study Board in "Impact Analysis of Kiskitto Lake Regulation" by I. W. Dickson, July, 1973. The modification proposed was to construct a weir with stoplog controls to a control elevation of 694 ft. The main advantage of this modification is that it allows greater flexibility in the control of the lakes's elevation and would permit the lake to be managed for enhancement of wildlife habitat and recreation opportunities. Construction of this weir has been completed and the lake level is being held at 694 ft until a management program is developed.

TABLE 6-3
KISKITTO LAKE MEAN MONTHLY WATER LEVELS

| Water Level | Regulated | Unregulated | Change |
|---|---|---|---|
| Maximum | 698.3 ft | 702.0 ft | -3.7 ft |
| Average | 697.3 | 693.7 | +3.6 |
| Minimum | 695.2 | 686.6 | +8.6 |
| Range | 3.1 | 15.4 | -12.3 |

TABLE 6-4
CROSS LAKE MEAN MONTHLY WATER LEVELS

| Water Level | Regulated | Unregulated | Change |
|---|---|---|---|
| Maximum | 686.5 ft | 685.1 ft | +1.4 ft |
| Average | 677.9 | 678.5 | -0.6 |
| Minimum | 673.4 | 674.8 | -1.4 |
| Range | 13.1 | 10.3 | +2.8 |

NOTE: *Based on modified historic data for the period 1928-66.*

CROSS LAKE- The changes in the water regime of Cross Lake resulting from the regulation of discharges from Lake Winnipeg will be different from the changes to Playgreen and Kiskittogisu lakes because Cross Lake is downstream of the Jenpeg control structure. Table 6-4 provides a comparison of water levels on Cross Lake with and without the regulation of Lake Winnipeg.

With regulation, the average water level of Cross Lake will not change substantially from the unregulated state. At elevation 677.9 ft, the average mean monthly level will be 0.6 ft less than under unregulated conditions. With regulation, the minimum mean monthly water level is anticipated to be 673.4 ft, 1.4 ft lower than under unregulated conditions. The maximum mean monthly level is expected to be 1.4 ft higher under regulated conditions.

With regulation, the magnitude of change in mean monthly water levels from one month to the next is most dramatic on Cross Lake (Fig. 6-9). Under unregulated conditions, Cross Lake average mean monthly water levels rise and fall gradually over the year with the minimum level occurring in March and the maximum level in July. Average month to month water level changes have been less than one foot. However, in flood years, water level fluctuations have been as high as 2.6 ft within one month.

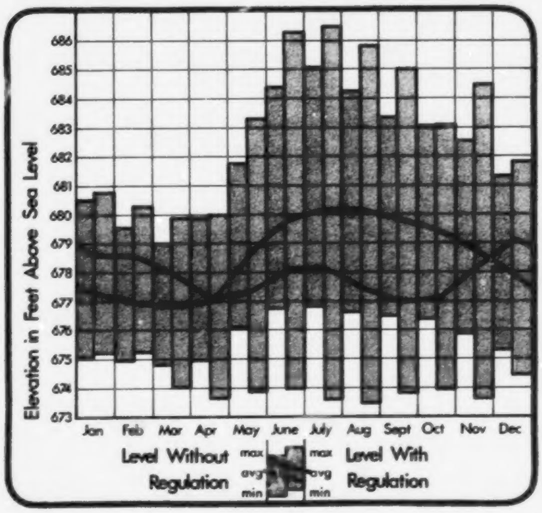


Fig. 6-9.
Cross Lake Water Levels.

With regulation, the seasonal pattern of fluctuations will be reversed. Minimum levels will occur in April and September, and maximum levels in July and December. Under regulated conditions, winter levels will generally be 1.0 ft to 1.5 ft higher, while in summer, levels will be about 1.5 ft to 2.5 ft lower than under unregulated conditions. Average monthly water level changes will continue to be less than one foot, but in flood years, monthly fluctuations in the spring and early summer could increase to 3.3 ft.

SPECIAL OPERATING CONDITIONS AT JENPEG - All operating conditions of the Jenpeg control structure have been taken into account in calculating the discharges and levels in the Outlet Lakes which will occur with regulation, with one exception. Manitoba Hydro has indicated that broken ice cover could result in ice jams in the Outlet Lakes area and specifically in the excavated channels. This condition would reduce the discharge capacity of the river system and would be contrary to the objective of the project which is to supplement the outflow capacity of Lake Winnipeg. To facilitate the formation of a smooth ice cover upstream of Jenpeg, Manitoba Hydro, as an operating measure, intends to reduce the discharge at Jenpeg significantly [to about 50,000 cubic feet per second (cfs)] for two or three weeks in November each year. After the ice cover has formed, discharges at Jenpeg will be increased until normal operating discharges are achieved toward the end of December. This condition was not incorporated into the computer simulation program for the regulated condition and consequently is not reflected in the regulated data for the Outlet Lakes. The effects of this reduction in discharges on the levels of Cross Lake will be substantial. In most years, the level of Cross Lake will drop between 2.5 ft and 3.5 ft during the first 2 to 3 weeks of reduced flows. Under certain conditions, a maximum drop of 4 ft to 5 ft is anticipated. With the return to discharges which occur under normal operating conditions, lake levels will rise 3 ft to 4 ft during the first 3 weeks in December.

### ICE REGIME CHANGES

In general, the alterations in water levels and flows in the Outlet Lakes area due to the operation of works associated with the Lake Winnipeg regulation project, are not expected to have broad implications for ice conditions in the area. There are, however, a number of specific sites where ice conditions are expected to undergo substantial changes. Investigations into these changes were not undertaken; however, Manitoba Hydro has undertaken some preliminary investigations on ice conditions as they relate to transportation patterns in this area, and their findings are presented below. An ice monitoring program is presently being planned by Manitoba Hydro.

Substantial changes in ice conditions are anticipated with regulation at channel constrictions. Weak ice conditions are expected near the outlet of the 2-Mile Channel, in the natural outlet of Lake Winnipeg to Playgreen Lake, and at two locations on Little Playgreen Lake near Norway House (Fig. 6-10). Similar conditions are expected to occur near the inlet of the 8-Mile Channel, Ominawin Bypass Channel, and in the immediate vicinity of the Jenpeg control structure. It is anticipated that the ice on the Jenpeg forebay will crack and slump over the winter as the water in the forebay is drawn down. On Cross Lake, it is estimated that increased flows will result in weaker or thinner ice in restricted channels at the south end of the lake; these sites include the narrows separating the community of Cross Lake and at least two locations along the present winter road route.

As indicated in the preceding section, Manitoba Hydro will reduce flows through Jenpeg in November. During this period a smooth ice cover will form upstream and downstream of Jenpeg. When discharges are returned to their normal operating level, the ice cover downstream may be flooded and weakened.

## CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER

The chemical, bacteriological and physical composition of the water flowing through the Outlet Lakes is not anticipated to change substantially as a result of the construction and operation of works to regulate discharges from Lake Winnipeg. Lake Winnipeg is the prime source of water for the Outlet Lakes and with regulation it will continue to be the primary source. An increase in suspended sediments due to channel excavation has occurred during construction and it will continue to increase.

Prior to 1972, there was only one site (Warren Landing) where water samples were taken regularly (four to six times a year). For the purpose of this study six additional sites were added: Sipiwesk Lake, Cross Lake, Eve Falls, Jenpeg, Norway House, and Kisipachewuk Rapids. Samples were taken once a month at Cross Lake, Eve Falls, Jenpeg, Norway House, and Kisipachewuk Rapids. Samples of Sipiwesk Lake and Warren Landing were taken once a month during the months of June, July, August, September, and October, three times during the period November, December, January, February and March, and once over the period April to May. After April 1973, the sampling sites at Kisipachewuk Rapids and Eve Falls were

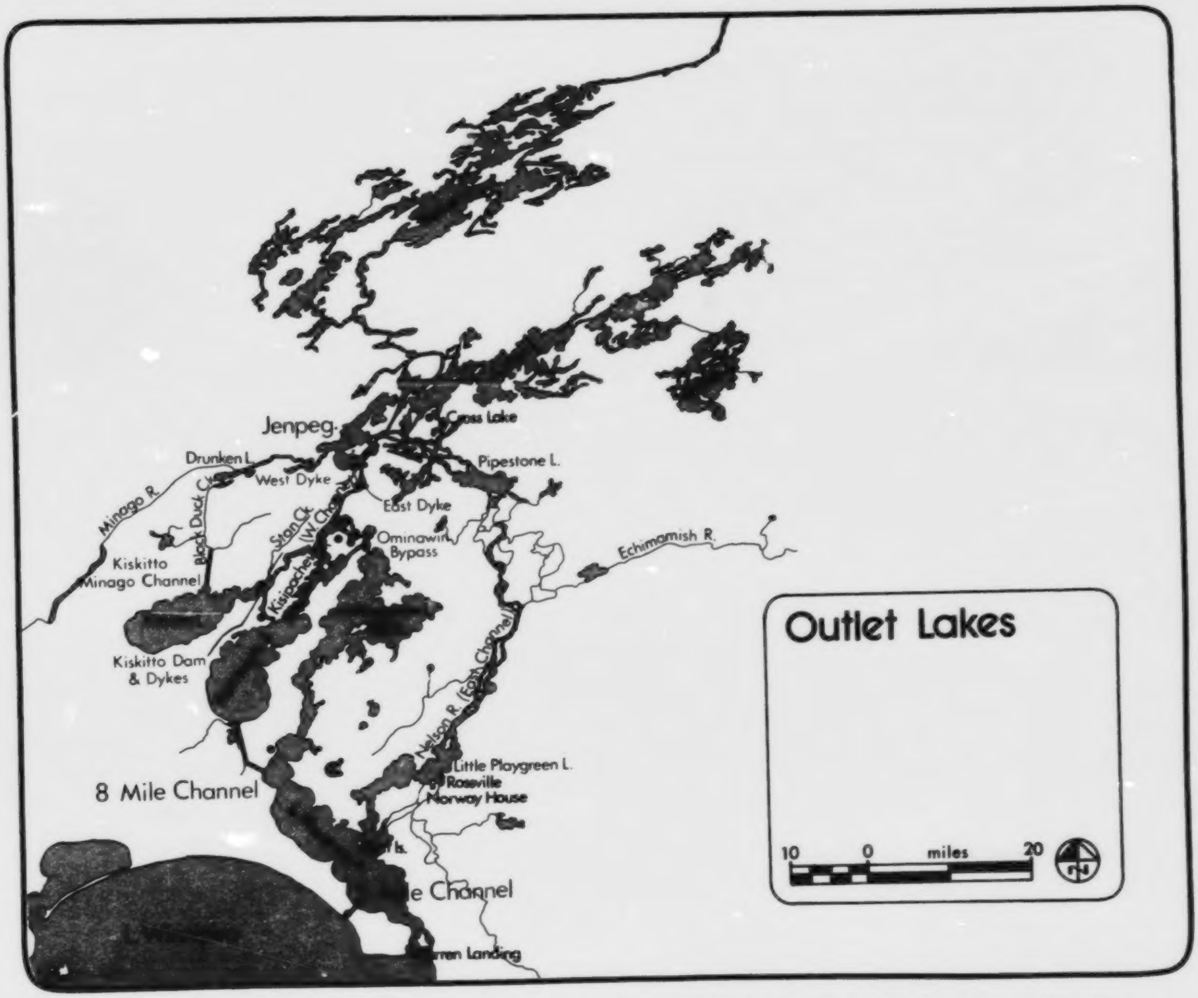

Jenpeg
Cross Lake
Drunken L.
West Dyke
Pipestone L.
Minago R.
Black Duck Cr.
East Dyke
Stan Cr.
(W. Channel)
Ominawin Bypass
Echimamish R.
Kiskitto Minago Channel
Kisipachewuk
Outlet Lakes
Kiskitto Dam & Dykes
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
8 Mile Channel
Is.
e Channel
Landing
10
0
miles
20

Fig. 6-10. Areas Where Open Water is Anticipated to Occur in Winter with the Regulation of Discharges from Lake Winnipeg.

dropped. In their place two new sites were established: Cross Lake at the Minago River mouth and Bladder Rapids. This last site (Bladder Rapids) was discontinued after September, 1973.

It was felt that more sites were required in the Outlet Lakes area, therefore, the following sites were included: Lake Winnipeg at the 2-Mile Channel, Playgreen Lake at the 2-Mile and 8-Mile channels, Kiskittogisu Lake, and Kiskittogisu Lake at the 8-Mile Channel (east and west ends), and Kiskitto Lake. These sites were sampled in 1973 during the months of March, June, July, August, September, October and in 1974 during the months of February, June, July and September.

In general, there does not appear to be any specific impurity or bacteriological contamination in the water in the Outlet Lakes. Analyses indicated that there is a seasonal decrease in turbidity, colour, silica, total organic carbon and total phosphorus, and an increase in specific conductance, alkalinity, hardness, sulphate, calcium, potassium, sodium and total nitrogen, from summer to winter. Dissolved nutrient values in Playgreen Lake were high. Bacteriological analyses indicated generally that all the stations had low coliform organism counts; however, at Cross Lake on two occasions the total coliform count was high.

The water in Lake Winnipeg, although noted for its high turbidity, is much more transparent than the water in the Outlet Lakes. This implies a significant uptake of suspended matter within the Outlet Lakes which, on the basis of the characteristic grey-brown color, is apparently derived through wind action on the glaciolacustrine shore and bottom deposits. Playgreen and Kiskittogisu lakes have similar transparency values but Kiskitto Lake is much less transparent than Kiskittogisu Lake. While no values for the algal standing crop are available, indications are that the high turbidity of Kiskitto Lake (also of Playgreen and Kiskittogisu lakes) is induced by wind action on its sediments and shores rather than by algae.

The average transparency in Cross Lake was the highest of all the Outlet Lakes. However, closer examination revealed that readings taken along the actual Nelson River discharge corridor were comparable to those of the other lakes. The eastern portion of Cross Lake which is less subjected to the Nelson River influence, and where the shorelines are primarily bedrock-controlled, is much more transparent.

Manitoba Hydro has initiated an extensive program to monitor inshore suspended sediment characteristics along twenty-three transects involving some 200 stations in the area of Warren Landing and at the inlets and outlets of the 2-Mile and 8-Mile channels. Cursory inspection of some 10,000 analyses indicated that no firm general conclusions can yet be reached on the comparative background sediment load of the water in these inshore locations.

The works that are under construction to regulate the discharges from Lake Winnipeg are expected to affect the transparency values of the Outlet Lakes. It is anticipated that during periods of strong onshore winds in the vicinity of the 2-Mile Channel entrance, a greater load of suspended sediment material will be transported into Playgreen Lake than that which now enters via Warren Landing. An eastward littoral drift has been identified along the north shore of Lake Winnipeg to the Warren Landing area; however, the rate of transport of material appears to be slow. Perhaps more significant is a northward drift into the outlet area along the east shore. This shore has extensive bedrock and coarse materials which, as is evident from Secchi disc transparency readings, impart a lesser sediment load than the glaciolacustrine clays and silts of the north shore. The north shore deposits produce a very pronounced local turbidity during onshore winds. This effect, augmented by such shore drift as may exist at the 2-Mile Channel entrance, will presumably provide sediment-laden water for delivery through the new channel into Playgreen Lake. This will occur during the ice-free period when winds are southerly. The magnitude of this predicted sediment transport phenomenon has not been estimated but it will probably be most noticeable in Playgreen Lake between the 2-Mile and 8-Mile channels, and perhaps in Little Playgreen Lake and the East Channel.

A long-term monitoring program is required to assess accurately the effect of the regulation works. Such a program was designed, and recommended for implementation in 1974. Part of this program called for the recording of changes in turbidity.

## PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS

Changes in physical characteristics of the shorelines of Playgreen, Kiskittogisu, Kiskitto and Cross lakes, and of the 2-Mile, 8-Mile, East and West channels were investigated. All shorelines on these lakes and channels were categorized according to a system developed by the Department of Civil Engineering, University of Manitoba, in 1972. The system combined specific physical characteristics into fifteen typical shoreline profiles. The physical characteristics considered included: general morphology, stratigraphy, and composition of shoreline materials; type, zonation, density and size of vegetation; drainage characteristics; and the occurrence of permafrost. The effects on the erosional and depositional processes of the construction and operation of the works associated with the regulation of Lake Winnipeg were analysed and the subsequent development of a stable shoreline profile was predicted.

PLAYGREEN LAKE - Approximately one-half of the shoreline of the south basin of Playgreen Lake is, in general, low relief with poorly drained clay soils overlain by considerable organic material. Offshore emergent vegetation consists of pondweed and bulrush. A narrow beach is present at the shoreline and is backed immediately by a low but steep bank. Along the top leading edge of the bank a narrow band of willow generally occurs but more often an open black spruce forest extends several hundred feet back from the shoreline. Drainage is usually impeded away from channels resulting in a treed muskeg area behind the black spruce band with scattered tamarack, sedges and herbs. Such an association is referred to as a treed muskeg shoreline.

The remaining half of the shoreline of the south basin is referred to as a floating fen. This shoreline is characterized by an organic deposit underlain by unconsolidated materials. Relief is essentially lacking and shallow water extends some distance landward while extensive flat meadow fens make up the backshore. A narrow ridge or storm crest less than 2 ft high characterizes the immediate foreshore; this ridge is usually covered with various species of willow. The vegetation behind the storm crest is dominated by sedges (*Carex* spp.) and horsetails (*Equisetum* spp.) intermingled with sundews (*Drosera intermedia*) and stunted shrubs such as bog myrtle (*Myrica gale*).

As described in the section on Water Regime Changes,the mean water level of the south basin will be higher under regulated conditions, but peak levels will be reduced. Therefore, it is anticipated that these shorelines will not change substantially under regulated conditions. The slightly higher mean water levels will not completely inundate shoreline vegetation, and most species should survive. The higher mean level is not expected to change present rates of erosion.

The north basin of Playgreen Lake differs substantially from the south basin in that about one-half of the shoreline of the north basin is low bedrock with a thin clay overburden. This shoreline is characterized by irregular, low bedrock rising abruptly from the water surface making it impossible for emergent vegetation to become established in the deep waters close to shore. The foreshore is essentially barren with only a few hard pioneer grasses and herbs present; further inland there is a wide zone of deciduous scrub leading, in most cases to an open coniferous forest.

Under the regulation, mean water levels in the north basin will rise by approximately 2 ft which will cause erosion of the thin clay overburden. Since the foreshore area is essentially barren only a relatively small amount of vegetation will be flooded.

The remainder of the north basin is generally treed muskeg similar to the type found in the south basin. The 2 ft increase in mean water levels will cause substantial flooding in these areas because the change in elevation between the shoreline and the backshore is small. The steep but low bank immediately behind the beach will slump and erosion of organic material will occur.

KISKITTOGISU LAKE- The rounded southern shoreline of Kiskittogisu Lake is in general, smooth interrupted only by gentle protuberances. The basin lies on a deep deposit of Agassiz clays and silts which have been subjected to erosion by the waves of frequent storms on the lake. Two-thirds of this shoreline is treed muskeg and the remainder floating fen.

As discussed in a previous section, the mean water level will rise approximately 3 ft with regulation. The elevation of the shore is low and approximately 1.5 square miles will be flooded as a result of the 3 ft rise in water level. As on Playgreen Lake, the low bank behind the beach will probably slump and erosion of organic material and silts and clays will occur. In the long-term, a new shoreline will become established at a higher elevation and new shoreline vegetation will emerge.

In the floating fens, portions of the wooded areas will be flooded and vegetation will die because the root collar will be submerged. Some areas of the shoreline may become very productive biologically. Flooding of organic deposits could result in sufficient production of invertebrates and vegetation to attract certain species of waterfowl. In other areas, floating organic debris will accumulate along shorelines within a relatively short period of time and backshore vegetation tolerant of the higher water levels will establish itself.

Treed muskeg shorelines are found in the bays at the north end of the lake; changes similar to those described on the south basin are forecast. However, the major part of the shoreline can be classified as bedrock-controlled with a thin overburden of lacustrine clays.

The north-eastern end of Kiskittogisu Lake lies on irregular Precambrian bedrock, but these irregularities are reduced by Agassiz sediments which fill all depressions. Relief is moderately low; the shoreline is very irregular with low bedrock promontories and small round bays.

Bedrock outcrops are very low, often less than 4 to 6 ft above water level at distances of 20 to 30 ft inland from the lake. The rock is glacially scoured gneissic granite and diorite. Small sand beaches backed by low clay or silty-clay banks are also common. Scattered herbs grow on the edges of the outcrop, but occasionally jack pine (*Pinus banksiana*) and black poplar (*Populus balsamifera*) may also be found. The overburden behind the outcrop supports a closed forest of either trembling aspen (*Populus tremuloides*) or black spruce (*Picea mariana*) often within an understory of alder (*Alnus* sp), dogwood (*Cornus stalinifera*) and highbush cranberry (*Vibernum trilobum*).

Detailed contour mapping is not available for this area so that the extent of the flooding that will occur cannot be determined. The clay overburden will erode and a new shoreline will develop. Vegetation is generally sparse; therefore only small amounts will be flooded. However, some offshore vegetation will die owing to submergence but new vegetation is expected to grow at higher elevations.

The northwest shore of Kiskittogisu Lake is extremely irregular but low bedrock shorelines predominate. Relief is moderately low and the small bays between the bedrock promontories contain varying depths of Agassiz sediments. The bays are characterized by offshore emergent vegetation consisting of rushes (*Scirpus* spp.) and sedges; backed by low clay banks often 4 to 6 ft above water level. No slumping in these areas has been observed when the water level was as high as 711.9 ft. Therefore, it is anticipated that there will be only minimal slumping under the regulated mean water level of 712.25 ft. However, when the lake is at its maximum regulated level of 714.95 ft there will be slumping and major losses of vegetation are anticipated because of the low relief. It is expected that trees at the new high water line will be undercut,fall into the water, and accumulate along the shoreline. In the backshore areas, a band of trees will die because their root collars will be flooded. Stabilization of these shorelines is anticipated to be slow due to the accumulation of driftwood and timber.

KISKITTO LAKE - As described in the previous section on Water Regime Changes, Kiskitto Lake will be regulated independently of Lake Winnipeg and the Outlet Lakes. Since water levels will be essentially constant and the range of fluctuation will be reduced, it is anticipated that there will be little effect on the shorelines and vegetation.

CROSS LAKE - Cross Lake has approximately 870 miles of shoreline of which approximately 800 miles are bedrock-controlled. The bedrock is typically granite and gneissic granite. Relief is generally low with an average rise of 10 ft in the first 100 ft back from the shoreline (Fig. 6-11).

Permafrost is discontinuous around the lakeshore and melted permafrost depressions are common. Vegetation in these depressions is typically alder, willow and sedge, with a large variety of grasses (*Grammineae*). Vegetation along the bedrock-controlled shorelines is similar to that found along Kiskittogisu Lake, and is, in general, sparse.

Fig. 6-11. Photograph of Typical Shoreline Around Cross Lake, 1972.

Cross Lake with 241 miles of shoreline has extensive marshy shores; along 201 miles of shoreline the bedrock is overlain by sediment supporting quick growing sedges and bulrushes.

As described in the previous section on Water Regime Changes, the range of water levels on Cross Lake will increase by approximately 3 ft. The maximum regulated water level will be slightly higher (1.41 ft) and the minimum regulated water level will be slightly lower (1.37 ft). Following regulation, the seasonal distribution of lake levels will be changed with generally lower levels in summer and higher levels in winter.

These water level changes are not expected to cause more than slight soil erosion and this will be primarily from the backshores of the bedrock-controlled shorelines. The water regime of high levels during winter and low levels during summer should not have detrimental effects upon marsh plants and in fact may encourage their development. Winter ice scour, however, could remove large permafrost marsh plants such as bulrushes from fast flowing reaches in the western end. Small, quickly growing species (*Carex* spp.) should flourish on bottom sediments exposed in summer.

WEST CHANNEL - The West Channel has approximately 158 miles of shoreline of which 131 miles are bedrock-controlled with shallow or negligible overburden. The remaining 27 miles are either treed muskeg, low willow shoreline, or shoreline formed on deep glacial deposits. Relief is generally low. Overburden is thin along most of the backshore. Drainage is generally good throughout this profile; although, permafrost may be found where organic layers provide insulation.

With regulation, water levels will rise to a maximum of 715 ft; at this elevation, approximately 21,821 acres of existing land surface will be flooded along the West Channel between Kisipachewuk Rapids and Jenpeg. Typical treed muskeg vegetation covers 9,105 acres, 11,779 acres are timber covered, and 937 acres have no forest cover. The vegetation cover has been removed from 12,000 acres prior to flooding. Vegetation in sheltered bays and from treed muskeg areas has not been removed. Riparian vegetation and most taller deciduous trees in these areas will survive unless the plant is completely inundated. Conifers, being less tolerant to flooding, will die within 3 years. Drowned trees will contribute to floating debris in the channel after flooding; however, in the early years, fallen, broken, and burnt trees that are presently lying on the forest floor will make up the major portion of the debris.

In the cleared areas, low stumps have been left and the ground cover has been virtually undisturbed. This firm mat will resist the forces of erosion after inundation. With the exception of steep shorelines and the wavewashed zone, cleared lands should remain stable and intact. It is not expected that there will be substantial debris from cleared areas since vegetation was piled and burned, leaving the area relatively clean.

EAST CHANNEL - Shorelines of the East Channel are typically bedrock-controlled. Relief is generally low and outcrops of bedrock are common. Overburden is thin consisting mainly of lacustrine sediments, clays, and sand. A marsh edge generally composed of sedges and bulrushes is common except where the flow is too great. Burned-over areas are common and typically have a regenerated cover of trembling aspen, white birch, jackpine and black spruce.

As discussed in the prior section on Water Regime Changes, about 15 to 20 percent of the water discharged from Lake Winnipeg flows down the East Channel. With regulation, maximum discharges will be lower through this channel, and consequently none of the shoreline will be flooded. Changes in shoreline vegetation profiles are, therefore, expected to be negligible.

8-MILE CHANNEL - The 8-Mile Channel is being excavated by hydraulic-suction dredges. The dredged material (dredge spoil) is being deposited on the adjacent landscape. The dredge spoil consists of clays, silts, and peat. The clay has a tendency to form fist-sized balls which are deposited adjacent to dykes bordering the channel. The finer materials, however, flow out onto the landscape submerging the root collars of plants and trees causing them to die (Fig. 6-12). Although over 50 square miles have been designated for the deposition of dredge spoil, the actual area to be covered will be considerably less. The spoil is fertile and, in areas where it has been deposited, grasses began to grow within a short time.

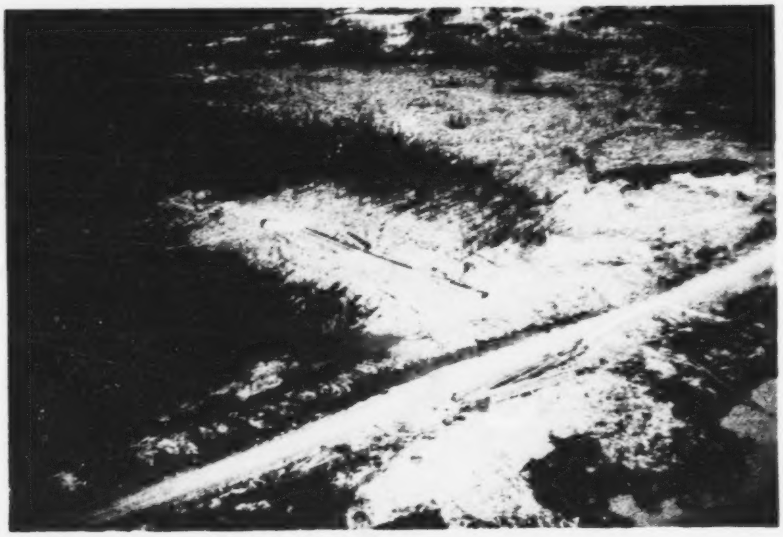


Fig. 6-12. Photograph of Dredge Spoil being Deposited behind Dykes at 8-Mile Channel, 1973.

The dykes along the channel have been constructed by two methods: directly depositing dredge spoil along the channel edge, and by dumping borrow pit material from trucks along the channel. The dredge spoil dykes are along the section of the channel which runs through the Kiskittogisu River. These dykes will probably undergo some erosion by waves on the Kiskittogisu River. This wave effect would be minimized if the level of the local river could be kept below the crest of the dyke, but this does not appear possible because of the low crest elevation of the dyke. In fact, water will probably flow in both directions over these low dykes, depending on the fluctuating levels on either side of the dyke. Erosion could be rapid where channels develop across the dyke.

If the dredge spoil dykes along the lower channel are constructed with at least 3 ft of freeboard, then they should not experience any increase in rate of erosion because of the longer duration for high lake levels on Kiskittogisu Lake. The height of waves approaching the dykes is primarily dependent upon wind velocity and fetch, which do not change. Additional dredging will have to be carried out or alternatively winter-hauled material brought in, if this increase in height of dyke is deemed necessary.

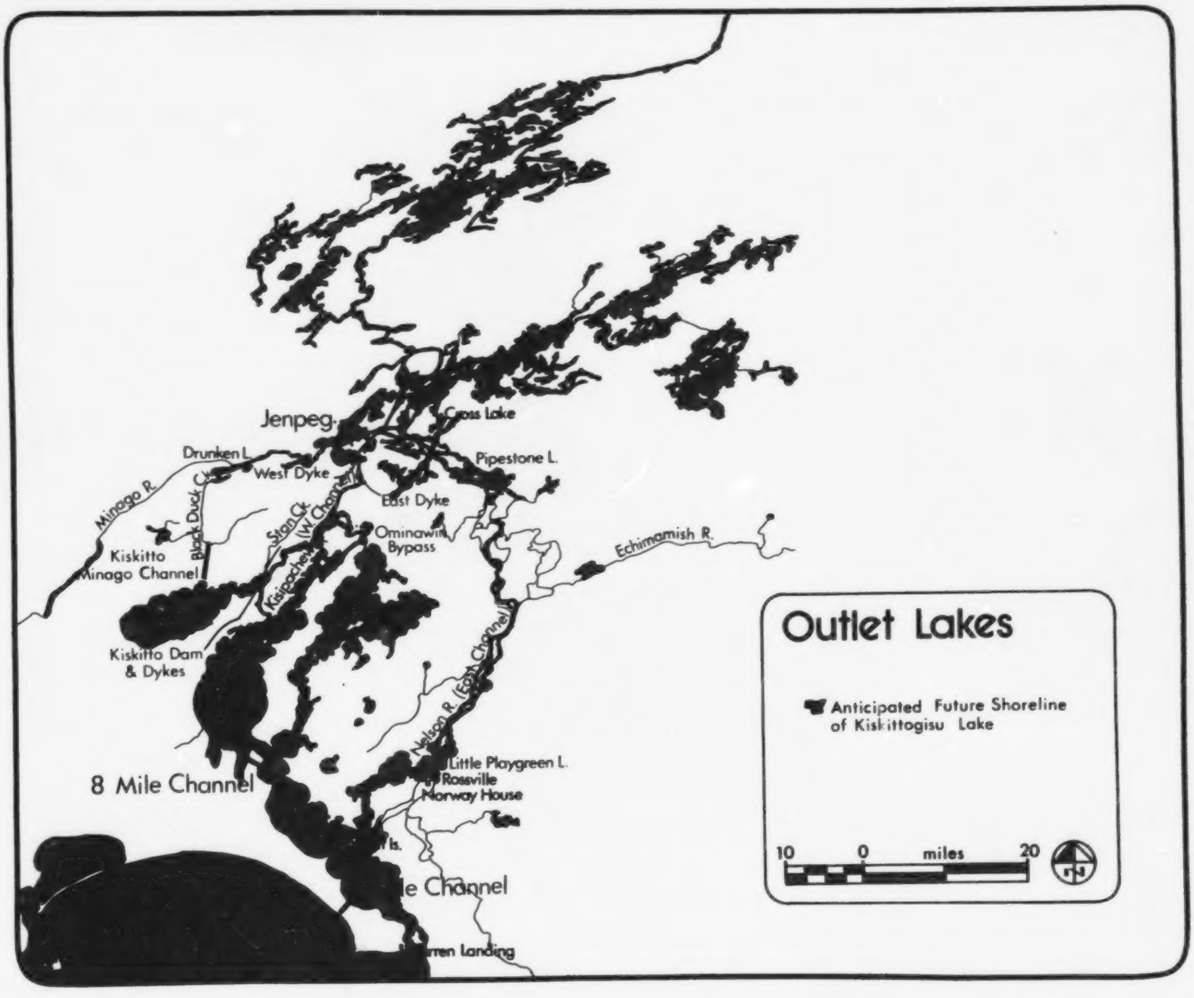
The truck-dumped dykes at the upper end of the channel in general have adequate freeboard. In addition, they are set back from the channel and have received considerable compaction from the trucks. A weak feature is the fact that they are situated on peat which is a highly compressible material.

The weak foundation of the dykes combined with a relatively high rate of erosion along this channel, is expected to result in a shifting of the channel shoreline. The exact location is difficult to predict, but it is anticipated that the southern shoreline of Kiskittogisu Lake will move substantially southward (Fig. 6-13) towards Playgreen Lake. This movement could be prevented by the construction of dykes parallel to the lakeshore. These dykes would have to be riprapped in order to prevent eventual destruction by lake waves. The existence of the dykes will result in a shift of the present sand beach to a higher elevation adjacent to the dykes. Also, the stable dykes along this shoreline would prevent the erosion of the channel dykes at the lower end. The channel dykes will then have to withstand wave action only from waves that are generated in the channel or in the Kiskittogisu River.

Preservation of the shoreline of the Kiskittogisu River, and the dredge spoil dykes along the lower part of the channel would confine a large area of floating peat. Floating peat would have severe detrimental effects to the local environment, while movement of material out of the area would adversely affect aquatic habitats downstream.

2-MILE CHANNEL - Dredging operations on the 2-Mile Channel had not begun at the time of writing this report; however, similar environmental effects to those at the upper end of the 8-Mile Channel are anticipated. Dredge spoil will be deposited behind dykes along the channel. The designated spoil area is 10,000 ft on either side of the channel and spoil will be kept at least 1000 ft from the edges of Winnipeg and Playgreen lakes. Spoil will kill vegetation where it submerges the root collars. However, as with the spoil from the 8-Mile Channel, it will probably be reasonably fertile, and grasses will begin to grow soon after deposition.

Erosion of the shoreline at the entrance to the 2-Mile Channel, due to high waves on Lake Winnipeg, may be serious and may cause bank instability and slumping in the vicinity of the entrance.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Rossville
Norway House
8 Mile Channel
Is.
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Outlet Lakes
Anticipated Future Shoreline of Kiskittogisu Lake
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Fig. 6-13. Anticipated Future Shoreline of Kiskittogisu Lake and 8-Mile Channel with an Unconfined Channel.

# EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION

## LIMNOLOGY AND FISHERIES

The construction and operation of works associated with the regulation of Lake Winnipeg will change the limnology of the Outlet Lakes, resulting in ecological changes affecting the fisheries. The Fisheries and Marine Service, Canada Department of the Environment, investigated the existing state of the limnology and fisheries in the Outlet Lakes and on this basis predicted the effects resulting from the regulation of Lake Winnipeg.

The report focused on Playgreen, Kiskittogisu, Kiskitto, and Cross lakes and on the connecting portions of the Nelson River. Little Playgreen, Pipestone, Walker and Drunken lakes received little attention owing to a combination of lack of information and relatively low or unpredictable effects. Virtually no specific limnology-fisheries field work was undertaken in this geographical area. The existing status and historical background of the fisheries were examined and fishery potentials and critical factors in productivity were defined. The major issues confronting these fisheries in terms of the regulation project were defined and the various effects were evaluated.

LIMNOLOGY - The lakes in the Outlet Lakes area are situated on the Canadian shield but the glaciolacustrine clays and silts which predominate in the surficial deposits of the area exert a marked edaphic effect on the waters. The lakes range in water area from 4.2 square miles (Drunken) to 250 square miles (Playgreen), and occupy a combined area of about 740 square miles. From 36 to 70 percent of the individual lake areas are less than 10 ft deep at normal supply levels. Significantly greater depths are confined to corridors of active water movement. Except for Cross Lake, shorelines are somewhat more regular than is characteristic of Shield lakes. The shoreline of Cross Lake is predominantly bedrock-controlled, and is extremely irregular. Water renewal times range from about 2 days in channels connecting major lakes, to 2 years or more in basins isolated from the main flow such as Kiskitto Lake.

The lakes remain nearly isothermal during the ice-free season. Surface temperatures do not exceed 68°F. The Lake Winnipeg discharge exerts a warming influence in summer and autumn, and retards autumn cooling. This reflects the greater warming and massive heat inertia of Lake Winnipeg to the south.

Dissolved oxygen remains saturated or near-saturated at all depths in all lakes in summer. Significant depletion only occurs under the ice at inshore stations in isolated bays removed from the main channel of the Nelson River.

Water in the Outlet Lakes is less transparent than that of Lake Winnipeg indicating resuspension of sediments by wind and current action from the glaciolacustrine shore and bottom deposits. Greater turbidity in Kiskittogisu Lake than in Playgreen Lake is evident only during high winds, thus demonstrating the role of the Nelson River in clearing the lakes. Kiskitto Lake is the most turbid of the lakes examined, and is also the most isolated from the Nelson River. The east basin of Cross Lake is less turbid than the section receiving Nelson River discharge. Turbidities of the degree encountered in the Outlet Lakes would inhibit biological productivity. Total dissolved solids of about 230 parts per million and pH of 7.5 to 8.0 reflect the influence of the Lake Winnipeg discharge. Major ions tend to increase in concentration through Playgreen and Kiskittogisu, but exhibit some dilution in the other lakes. Nutrient ions and complexes along with the heavy metals (notably mercury and zinc) appear to be retained in passage through these lakes. Nutrient loading values are very high, due to the massive water discharge.

Amphipods (particularly *Pontoporeia affinis*), sphaeriids (particularly *Sphaerium* sp.), and large burrowing mayfly nymphs (*Hexagenia* sp. and *Ephemera* sp.) generally dominate the zoobenthos of these lakes. Notable is the scarcity of dipteran larvae. Mayflies probably make a significant contribution to the amount of fish food present. Of these the most important is *Hexagenia*, which is abundant where the discharge of the Nelson River is less apparent. The standing crop of bottom fauna is greatest in those areas which receive the full discharge of the Nelson River, but which are large enough to reduce the time of flushing (e.g., the south and north basins of Playgreen Lake). Standing crops of benthos are lowest in the most isolated basins (e.g., Kiskitto Lake and the main part of Kiskittogisu Lake).

At least twenty-one fish species occur in these lakes, including lake whitefish (*Coregonus clupeaformis*), cisco (*Coregonus* sp.), walleye (*Stizostedion vitreum*), sauger (*Stizostedion canadense*), northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), goldeye (*Hiodon alosoides*), lake sturgeon (*Acipenser fulvescens*), and suckers (Catostomidae). Playgreen Lake appears to have the greatest overall standing stock of fish; Kiskittogisu and Cross lakes have about half as much, and Kiskitto about half as much again. Playgreen Lake is probably somewhat more productive of fish than the best lakes along the lower Churchill River; with the other Outlet Lakes ranked in the approximate order of their standing stocks. Whitefish generally decrease in abundance, growth, size, and condition from the south basin of Playgreen Lake downstream and into the main basin of Kiskittogisu Lake. Growth appears to increase again in Cross Lake. Pike are larger, fatter and more abundant in Playgreen Lake (especially the extreme south end) than in Kiskittogisu, but are slightly larger at specific ages in the latter. Walleye productivity is linked to the availability of tributary streams, such as Kiskittogisu River, Minago River and Black Duck Creek, which are probably utilized for spawning. Walleye growth is slightly faster in Kiskittogisu Lake than elsewhere in these waters. Goldeye are encountered only downstream of Kiskittogisu Lake. Sturgeon are only known to occur in Playgreen and Cross lakes. Indications are that discrete populations of the economic fish species inhabit the main individual lakes, and that the commercial fisheries are based on indigenous stocks. The possibility of extensive fish exchange between Kiskitto and Kiskittogisu lakes is not disproved, however, and there are no data to assess such interchange for Cross, Pipestone, Drunken, and Walker lakes. Similarly, there are no data on fish migrations up and down the main channels of the Nelson River below Playgreen Lake, but it seems unlikely that this would be extensive. Whitefish tagged in Lake Winnipeg were recovered in Little Playgreen Lake, and it is probable that this is part of an important spawning phenomenon with major implications for the Lake Winnipeg whitefish fishery as well as for domestic fishing in Little Playgreen Lake.

## EFFECT ON LIMNOLOGY

Effect of the 2-Mile Channel - It is anticipated that during periods of strong onshore winds at the 2-Mile Channel entrance, a greater load of suspended sediment material will be transported into Playgreen Lake than now enters via Warren Landing (Fig. 6-14). Within Lake Winnipeg the rate of sediment transport from the north shore to the east shore is currently significant. The north shore deposits produce a very pronounced local turbidity during onshore winds. This effect, augmented by such shore drift as may exist at the 2-Mile Channel entrance, will presumably provide sediment-laden water for injection through the new

Fig. 6-14. Photograph of Slumping Banks in the Vicinity of the Entrance to 2-Mile Channel, 1972.

channel into Playgreen Lake. This will occur during the ice-free periods when winds are southerly; unfortunately it is impossible to predict its effects. Presumably the greatest increases in turbidity will be in Playgreen Lake between the 2-Mile and 8-Mile channels, and perhaps in Little Playgreen Lake and the East Channel. Primary productivity (phytoplankton and other vegetation) is inhibited by high turbidity. Since turbidity is high at present, very little reduction in primary production is expected with the opening of the 2-Mile Channel. Some complications may, however, arise from sedimentation. This could cause reduction of bottom fauna production in the south basin of Playgreen Lake. In addition, spawning sturgeon along the west shore of the south basin of Playgreen Lake might be affected. Sturgeon spawn in June, and the eggs are highly vulnerable to sedimentation. Sedimentation may also have deleterious effects on the spawning success of whitefish in the East Channel and in Little Playgreen Lake. However, since spawning occurs at the very end of the open-water period, and since the eggs hatch just before or during breakup, there would seem to be little danger of serious damage.

Some positive influence of the 2-Mile Channel on bottom fauna productivity might be anticipated in the extreme south end of Playgreen Lake. One manifestation of reduced flows through the channel at Warren Landing might be to promote mayfly production through the creation of suitable mayfly habitat.

It cannot be predicted whether fish will use the 2-Mile Channel for migration; in any case, it is difficult to envisage any potential benefits from such activity. Anticipated water velocities should not be such as to deter adult fish from moving freely through the channel in either direction. There is a possibility that the new channel might confuse present migration patterns, and perhaps disrupt what appears to be an important spawning movement of whitefish from Lake Winnipeg into Little Playgreen Lake. Observations suggest that movement of whitefish in the north basin of Lake Winnipeg is primarily in a clockwise direction so that fish moving to Warren Landing would tend to approach from the west. They would thus encounter the 2-Mile Channel before reaching the natural discharge corridor at Warren Landing, and might become disoriented.

Effect of the 8-Mile Channel - A direct result of the 8-Mile Channel will be an increase in the flushing rate of the main south basin of Kiskittogisu Lake. The present renewal time is estimated at 2 to 3 years but with normal operating conditions at Jenpeg, the renewal time will be reduced on average to between 11 and 17 days. This should provide a more favourable loading regime of nutrients, algae and allochthonous organic matter from Lake Winnipeg into Kiskittogisu Lake, but at a renewal rate which is not prohibitively rapid; Kiskittogisu Lake may be cleared of some of its internally-induced turbidity generated during the open water season.

Presumably these developments will augment the productivity of such important bottom organisms as *Pontoporeia*, *Sphaerium* and *Ephemera*, but will probably be somewhat detrimental to *Hexagenia*. The greater amplitude of annual water level fluctuations, on the other hand, will probably cause some reduction of bottom fauna production; reduction would also result from any turbidity caused by erosion of dredge spoil deposits or erosion of the new elevated shorelines. In general, however, it is predicted that the new water regime will tend to favour the bottom fauna and therefore whitefish production in Kiskittogisu Lake. Standing crops of benthic organisms should come to resemble more closely those now occurring in the south basin of Playgreen Lake; a two to three-fold increase might therefore be anticipated. There could be a significant improvement in whitefish growth and condition, perhaps eventually resulting in a "Premium" classification for the fish from this lake.

Northern pike, the final host of the whitefish parasite *Triaenophorus*, should be favoured by the new and higher water regime in Kiskittogisu Lake, but it is unlikely that any such increase in pike abundance will further reduce the quality of the whitefish, as the rate of *Triaenophorus* infestation is at present quite high. There might be a problem regarding whitefish recruitment. Kiskittogisu Lake has relatively little "preferred whitefish spawning habitat".

Destruction of the present Kiskittogisu River and lagoon system at the south end of Kiskittogisu Lake will probably cause a serious reduction of the walleye population. It seems likely that this is the major walleye spawning and rearing area, accounting for the fine stocks of walleye in Kiskittogisu Lake at present. Walleye productivity might be expected to drop by about half, stabilizing at approximately the same level as that now experienced in the south basin of Playgreen Lake.

Productivity impacts of the 8-Mile Channel will also be felt in the north basin of Playgreen Lake. The slower water renewal time through this area (from about 5 to 9 days under present normal conditions, to about 7 to 13 days under regulation) should increase bottom fauna and whitefish production. There will also be some reduction of winter oxygen concentrations which are already lowest in this part of the Playgreen-Kiskittogisu system; however this effect is unlikely to be of significance.

Utilization of the 8-Mile Channel by fish species is impossible to predict. It might provide an avenue of recruitment for whitefish and walleye of Kissittogisu Lake.

Effect of the Ominawin Bypass Channel - Little or no basis exists for predicting the impact on fish stocks in the natural channel and in the bypass channel. The natural channel appears to have the most attractive pike populations for sport fishing in this vicinity, and presumably physical disruption of the habitat would be disadvantageous. On the other hand, reduced discharge volumes through this channel should generally benefit pike and perhaps walleye as well.

Effect of Jenpeg - The Jenpeg forebay area is likely to be unproductive for bottom fauna and most fish species because of the extensive seasonal fluctuation in water level (about 12 ft in an ordinary operating year). Northern pike, however, are known to do well in new impoundments, at least initially.

The Jenpeg structure, without remedial facilities, will completely block any upstream fish migrations which may occur in this river section. A fish-attraction device and facility is recommended which, if fish are found to enter it, could be expanded and incorporated into a permanent fish passage facility. The Manitoba Department of Mines, Resources and Environmental Management will operate the fish-attraction device and facilities for moving fish over the dam. In the absence of data on fish migrations, it is impossible to evaluate the need for such a facility at the present time. It would seem that if such migrations were extensive, there would be some indication of them in the history and habits of the native people. If a significant spawning run of walleye does take place through this reach, much of its basis may be lost for other reasons, such as, the elimination of access to Kiskitto Lake, the destruction of the Kiskittogisu River and lagoons, or the change in water regime in the Nelson River channels.

There will be a significant decrease in annual heat transport from Lake Winnipeg into the Outlet Lakes due to increased discharge in winter when Lake Winnipeg is cold, and decreased discharge in summer when Lake Winnipeg is warm. This may have some adverse effect on biological productivity, although actual temperature shifts would presumably be slight. Some important bottom fauna species, such as *Pontoporeia affinis*, might actually be favoured.

Of possible greater significance is the reduced spring discharge, which might retard break-up, and the greater late-autumn discharge, which will presumably retard freeze-up.

The anticipated effects of increased water levels on Kiskittogisu Lake, including establishment of new shorelines, have already been noted. In the absence of appropriate mapping and other information this aspect cannot be considered in detail, although there may be some important impacts. Levels will also be substantially raised in the north basin of Playgreen Lake; however, in this case the levels will remain primarily within the natural range, and shoreline readjustments should not be significant.

The greater seasonal fluctuations in water levels in the north basin of Playgreen Lake and Kiskittogisu Lake will be to the detriment of the littoral fauna. The much greater April-May increase in levels under regulation should be advantageous for pike reproduction. However, the increased occurrence and extent of water level reductions between May and June could adversely affect incubation of walleye eggs in these areas. The much greater drop in levels between October and November should be too early in the season to seriously affect whitefish incubation.

Reduction of discharge under regulation in the West Channel in summer should improve the prospects for a tailrace sport fishery below the Jenpeg installation. The large annual fluctuation in levels in the forebay itself will be a serious constraint to productivity. This will essentially preclude successful reproduction of autumn-spawning fishes, and will seriously impair production of bottom fauna. These factors, along with debris problems, make it unlikely that the forebay will have a significant commercial fishery potential.

The much greater month to month fluctuations in flows in the various branches of the West Channel will be detrimental to the reproduction of any fish species (e.g., walleye) which may take place in these channels.

The more stable and somewhat greater flows in the East Channel (assuming no control structure is constructed) would presumably be beneficial to most aquatic life including, perhaps, incubation of whitefish eggs upstream in Little Playgreen Lake.

Effect on Cross Lake - The forecast reversal of seasonal regimes and the greater month to month fluctuations in water levels for Cross Lake are of considerable concern. However, the new regime will be established well within the historic elevations and since the lake is very shallow, the limnological benefits of higher winter levels will tend to compensate for the limnological disruptions due to fluctuations. Some reduction of pike and whitefish reproduction is anticipated resulting from a predicted increase in the frequency of severe declines in water level during the spring and autumn.

Effect on Kiskitto Lake - The much greater stability of water levels in Kiskitto Lake which will result from control should greatly benefit bottom fauna and fish production. It is anticipated that walleye, pike, and goldeye in particular, will experience a doubling of productive capacity. Whitefish food stocks should increase, however, there may be problems of whitefish recruitment which cannot be assessed from present data. As the lake is very shallow, adoption of a regime close to the top of the natural range will have beneficial effects from the viewpoint of the limnology and fisheries.

Erosion in the upper reaches of Black Duck Creek, and sedimentation in the lower reaches of the creek and in Drunken Lake, could be detrimental to the stocks of walleye and northern pike in the Drunken Lake-Minago River system.

FISHERIES - The Outlet Lakes contribute 3 percent of the current landings, and 8 percent of the value of the Manitoba commercial fishery. There are two significant domestic fisheries, but no sport fishery. Whitefish and walleye make up the bulk of the commercial gill-net harvest. About 60 percent of the commercial fishery occurs on Playgreen Lake. Economics of exploitation are strongly influenced by access from the three permanent settlements in the area: Norway House, Cross Lake and Warren Landing.

There will be changes in fish productivity in different lakes as a result of the proposed hydroelectric development but the overall effects on fish production potentials are not expected to be substantial. The hydroelectric development and new access road will probably result in a significant new sport fishery in the Jenpeg forebay and tailrace areas. New access will expand fishing opportunities throughout most of the area. On the other hand, the 8-Mile Channel will destroy significant walleye spawning habitat in the Kiskittogisu River. The Jenpeg operation will interfere with mobility of fishermen on Cross Lake, and inundation of shorelines will adversely affect fish exploitation in the Jenpeg forebay and Kiskittogisu Lake.

Lake whitefish, walleye, sauger, northern pike, goldeye, perch and lake sturgeon are the preferred species for commercial fishing and domestic consumption. Cisco, burbot (*Lota lota*), carp (*Cyprinus carpio*), and four species of suckers: white sucker (*Catostomus commersoni*), longnose sucker (*Catostomus catostomus*), shorthead redhorse sucker (*Moxostoma macrolepidotum*), and quillback sucker (*Carpiodes cyprinus*) are referred to as coarse fish species and are of less significance in the commercial and domestic fishery.

Mainly discrete populations of the economic species inhabit the individual lakes, and the commercial fishery is based on indigenous stocks except for adult whitefish which migrate from Lake Winnipeg to spawn in the Outlet Lakes.

Only walleye and pike contribute significantly to sport fish catches.

Commercial Fishery - The fishery operates on all lakes except Little Playgreen Lake. The total annual commercial fish quota for the eight lakes involved is 560,000 lb. Except for Playgreen Lake, which is fished primarily by residents from Norway House, preference in licensing for the other lakes is given to Cross Lake residents. The combined harvest over the past 12 years averaged 522,000 lb; the fishery is primarily a summer operation.

Landings and values, and their contribution to the Manitoba fishery, in recent years are shown in Table 6-5.

TABLE 6-5
TOTAL LANDINGS AND VALUES OF THE OUTLET LAKES COMMERCIAL FISHERY, SUMMER 1970 TO WINTER 1973-74

| | Total Landings | | Total Value to fishermen | |
|---|---|---|---|---|
| | cwt | Percent of Manitoba Fishery | $000 | Percent of Manitoba Fishery |
| Summer, 1970 | 7260 | 8.1 | 179.1 | 14.2 |
| Winter, 1970-71 | 99 | 0.1 | 1.5 | 0.2 |
| Summer, 1971 | 7274 | 8.1 | 173.4 | 11.9 |
| Winter, 1971-72 | 354 | 0.5 | 7.3 | 0.8 |
| Winter, 1972-73 | 6352 | N/A | 154.1 | N/A |
| Winter, 1973-74 | 7244 | N/A | 180.2 | N/A |

N/A - *Statistic not available.*

The Playgreen Lake fishery is the largest (Table 6-6). During 1960-71 it contributed 59 percent of the total average annual Outlet Lakes catch and 58 percent of total average annual value. Between 1960 and 1971, the average number of fishing licences issued for Playgreen Lake was 75. This accounted for approximately 65 percent of all the licences issued for the Outlet Lakes.

Average annual production (Fig. 6-15) has ranged from 0.29 lb/acre for Kiskitto Lake to 3.43 lb/acre for Drunken Lake. Average annual production was 93 percent of the quota for these lakes. Whitefish were the main contributors to marketed catch in Playgreen, Pipestone, Cross, and Walker lakes; walleye, the main contributors in Kiskittogisu, Kiskitto and Drunken lakes.

TABLE 6-6
SUMMARY OF COMMERCIAL FISHING PARTICIPATION, FISH PRODUCTION, AND VALUES TO FISHERMEN FOR OUTLET LAKES, 1960-71.

| Lake | No. of Licenses<br>Avg. per Yr. | <br>Percent | Fish Production<br>Avg. per Yr. (cwt) | <br>Percent | Value to Fishermen<br>Avg. per Yr. ($000) | <br>Percent |
|---|---|---|---|---|---|---|
| Playgreen | 75.0 | 65 | 3068 | 59 | 60.6 | 58 |
| Kiskittogisu | 2.8 | 2 | 191 | 4 | 4.2 | 4 |
| Kiskitto | 3.7 | 3 | 163 | 3 | 3.5 | 3 |
| Pipestone | 2.8 | 2 | 78 | 1 | 1.3 | 1 |
| Cross | 14.9 | 13 | 875 | 17 | 18.2 | 18 |
| Drunken | 2.3 | 2 | 93 | 2 | 2.7 | 3 |
| Walker | 14.8 | 13 | 756 | 14 | 13.7 | 13 |
| Totals | 116.3 | 100 | 5224 | 100 | 104.2 | 100 |

Ultimate production potentials, including species not presently utilized, probably exceed current commercial harvest rates by about two to ten times. However, recent annual production is probably the most reasonable basis, in most cases, for estimating present and future values.

Playgreen Lake production was moved by boat to the secondary receiving station in Winnipeg, at a cost of 4.75¢ per lb. Fish from the other lakes were usually flown to Wabowden at a cost of 4.1 to 6.3¢ per lb. Shipment from Wabowden (intermediate point) to The Pas (primary receiving station) and on to Winnipeg (secondary receiving station) cost another 3.05 to 3.75¢ per lb. In addition, agents (private owners and co-operatives) operating for the Freshwater Fish Marketing Corporation were allowed about 9¢ per lb to cover administration, packing and other labour, ice, and containers. These costs dictate to a considerable degree the economic feasibility of commercial fishing for particular species in particular lakes.

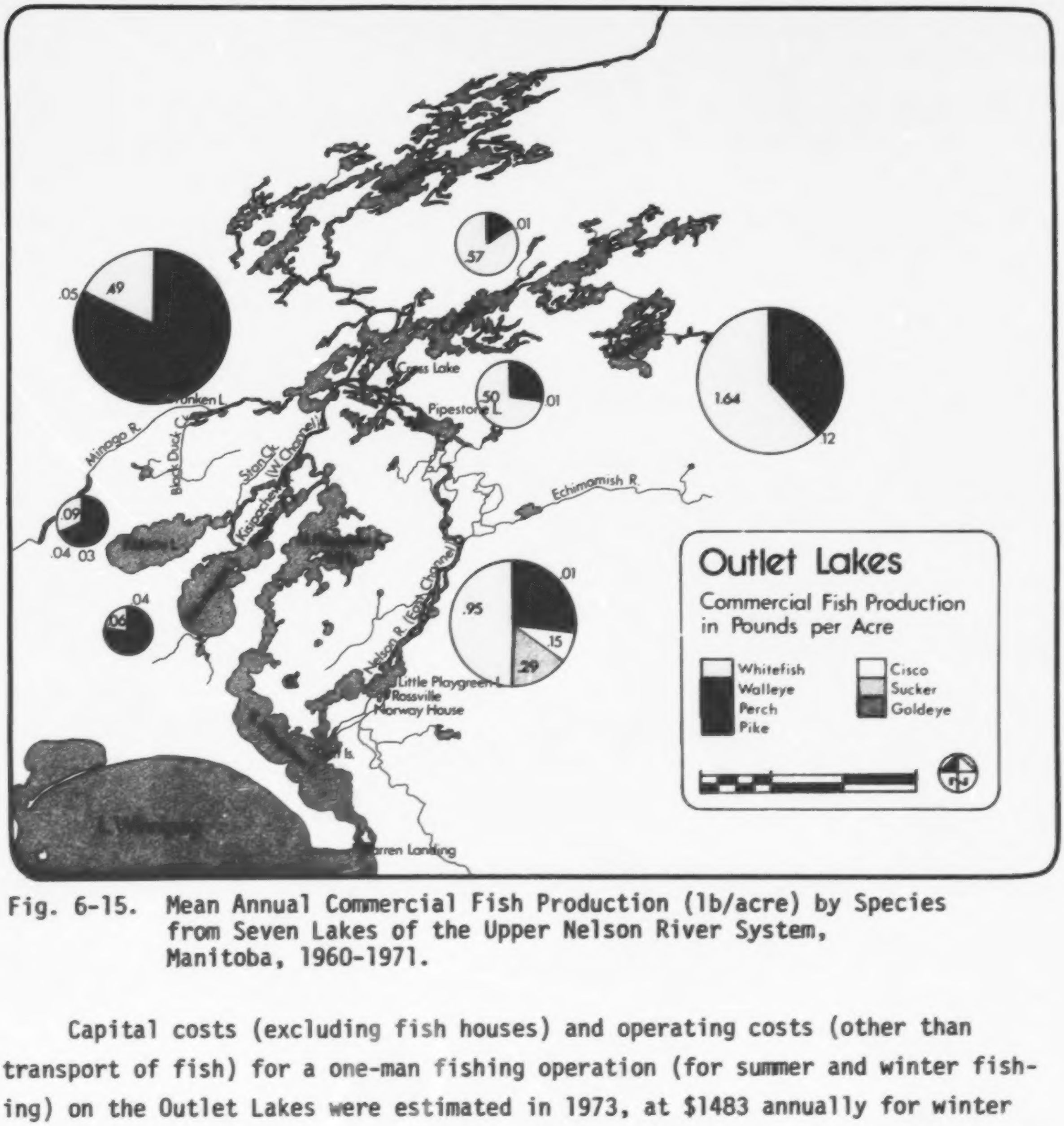

.01
.57
.05
.49
Cross Lake
.50
.01
1.64
.12
unken L.
Pipestone L.
Minago R.
Black Duck Cr.
Stan Cr.
(W. Channel)
Kisipachewuk
Echimamish R.
.09
.04
.03
.04
.06
Nelson R. (East Channel)
.01
.95
.15
.29
Little Playgreen L.
Rossville
Norway House
Is.
arren Landing
Outlet Lakes
Commercial Fish Production in Pounds per Acre
Whitefish
Walleye
Perch
Pike
Cisco
Sucker
Goldeye

Fig. 6-15. Mean Annual Commercial Fish Production (lb/acre) by Species from Seven Lakes of the Upper Nelson River System, Manitoba, 1960-1971.

Capital costs (excluding fish houses) and operating costs (other than transport of fish) for a one-man fishing operation (for summer and winter fishing) on the Outlet Lakes were estimated in 1973, at $1483 annually for winter fishing, and $1276 annually for summer fishing. Most operators earned less than $3000 per season in 1970 and 1971.

Domestic Fishery - Substantial domestic gill-net fisheries are conducted on Cross and Little Playgreen lakes. Estimates vary greatly, from 75,000 to 300,000 lb annually for Cross Lake, and from 100,000 to 400,000 lb annually for Little Playgreen Lake. Whitefish are believed to be the main species in domestic use, at least in Little Playgreen Lake. However, it is doubtful whether Little Playgreen could support a domestic removal of the magnitude indicated without migration of fish into the area.

One estimate is that domestic fish consumption by area residents averaged 150 lb per family per year in 1972. This suggests an annual domestic harvest of 105,000 lb by residents of Norway House, and 75,000 lb by residents of Cross Lake. The latter take their domestic harvest from Cross Lake, while most of the domestic catch at Norway House is taken from Little Playgreen Lake and the Nelson River channels, and is heavily dependent on spawning-run whitefish.

Another estimate of the Norway House domestic fishery is 250,000 lb annually. A further estimate is that domestic fish consumption averages 130 lb per person per year, and 900 lb per sled dog. On this basis, annual consumption would be 410,000 lb at Norway House, and 280,000 lb at Cross Lake. Consumption is presumably declining as sled dogs are replaced by power toboggans, but human consumption appears to be stable.

Sport Fishery - There is no concerted sport fishery at present; there are no facilities and very few tourists come to the area, and local residents have little inclination for sport fishing. There are some attractive stocks of walleye, particularly in Drunken Lake, and northern pike, particularly in the south basin of Playgreen Lake and in the Nelson River channels. The new and improved access resulting from the construction of the hydroelectric facilites will tend to improve the prospects for the development of sport fishing.

EFFECT ON FISHERIES - The overall anticipated effect of hydroelectric development for the area as a whole is a slight decline in fish productive capacity over the short-term (due mainly to a slight drop in productivity in Playgreen Lake), and a slight increase thereafter (due mainly to expected increases in productivity in Kiskittogisu and Kiskitto lakes). Upon completion of the 8-Mile Channel, the new water regime will favour bottom fauna and whitefish productivity in Kiskittogisu Lake. There could be a significant improvement in whitefish condition, perhaps eventually resulting in a "Premium" classification.

Effect of the 2-Mile Channel - Local implications of new boat access between Lake Winnipeg and Playgreen Lake via the 2-Mile Channel for transport of the commercial fish catch are not of major significance since adequate access already exists through the natural outlet at Warren Landing. At present, barges encounter some difficulty at Warren Landing during the extreme low water levels of summer droughts. Under regulated conditions, this will be avoided because water levels will be about one foot higher. Relocation of barge traffic from Warren Landing to the 2-Mile Channel will presumably require construction of extensive docking facilities on Playgreen Lake.

Implications of the 2-Mile Channel for commercial transport of fish cannot be evaluated for Playgreen Lake alone. In view of other developments, both underway and potential, the Kiskittogisu Lake fishery must also be considered, and possibly that of Cross Lake and neighboring lakes.

Effect of the 8-Mile Channel - The channel will allow barge access from Lake Winnipeg, which should facilitate the movement of the commercial fish harvest from Kiskittogisu Lake in summer. The commercial fishery on Kiskittogisu Lake will probably become more integrated with that on the south basin of Playgreen Lake, and may in future be more effectively conducted by operators from Norway House rather than Cross Lake. Debris from inundation will have some negative effects on fishing.

Effect of the Ominawin Bypass Channel - The West Channel appears to have the most attractive pike populations for sport fishing; presumably physical disruptions to habitat would be disadvantageous. Reduced discharge volumes in the channel should generally benefit pike, and perhaps walleye. The Ominawin Bypass will ensure easy boat access to these areas, and also to Lakes Kiskittogisu, Playgreen and Winnipeg, from road's end at the Jenpeg site.

Effect of the Jenpeg Forebay and Tailrace - Northern pike are known to thrive, at least initially, in new impoundments. Pike should benefit from the extensive forest inundation, but exploitation will be made more difficult by the standing timber and debris. Unless a complete clearing program is undertaken, it is unlikely that a commercial gill-net fishery could develop in the Jenpeg forebay in the foreseeable future.

The Jenpeg tailrace should provide excellent sport fishing for northern pike and perhaps walleye. Permanent road access along with viewing of the hydroelectric installation should promote extensive sport fishing. Jenpeg will undoubtedly serve as a departure point for fishing trips up the West Channel to

Kiskittogisu Lake and beyond.

Commercial fish output could be brought to Jenpeg from Kiskittogisu, Playgreen and Cross lakes for transport to Winnipeg by truck. Other new transportation alternatives are available, including transshipment from the Minago River crossing and a lock at Jenpeg.

As noted in the section on "Limnology", while reduction of discharge in the West Channel in summer under regulation should improve prospects for a tailrace sport fishery below the Jenpeg installation, the large annual fluctuation in levels in the forebay will be a serious constraint on productivity. This will preclude successful reproduction of autumn-spawning fish (e.g., whitefish). These factors, along with debris problems, make it unlikely that the forebay will have a significant commercial fishery.

Effect of the All-Weather Road to Jenpeg - The Jenpeg road provides vehicle access to the Minago River, the Jenpeg forebay and tailrace areas, the West Channel and Kiskitto Lake. The road opens the possibility of extending an all-weather or winter road from the West Channel to Norway House and Cross Lake communities. It also provides road-boat access to Drunken and Hill lakes, and the west end of Cross Lake.

The road to Jenpeg will increase opportunities to exploit fish stocks and to move the commercial fish production more cheaply. Boat access will be possible at normal water levels to both Cross and Drunken lakes from the road crossing point; this could have important implications for sport and commercial fish exploitation on these lakes, and would augment the value of the walleye stocks in the Drunken Lake-Minago River system.

Effect of Reduced Mobility on Cross Lake - Reversal of seasonal regimes and greater month to month fluctuations are forecast for Cross Lake. Disruption in human mobility is expected to accompany the new water regime. The general trend of rising lake levels during and immediately after freeze-up will make ice conditions difficult for winter fishing. The lower (2-3 ft) levels during July-August under regulation will probably affect boating mobility and could prevent boat access from Cross Lake to the adjoining lakes including Walker, Drunken, Hill and Pipestone for commercial and sport fishing. On Cross Lake much mobility would probably be lost with a four-foot drop (mean anticipated August level). The boat route to Walker Lake would appear to be particularly vulnerable to such a regime; the route to Jenpeg (or more particularly to the Minago crossing) would probably be less affected.

These anticipated mobility problems on Cross Lake might be alleviated by altering the outflow pattern from Lake Winnipeg to ensure an adequate water depth in summer and to maintain a relatively stable winter level. Summer levels could be raised artificially by building a control structure at the outlet of Cross Lake or alternatively by advancing construction of the Bladder Rapids project.

Effect on Fish Exploitation - Fish exploitation opportunity was indexed with attention to physical effects (new transportation corridors, hazards to boating and gill-netting), and anticipated developments in marketing. An important assumption was that coarse fish species (suckers and ciscoes) will be generally marketable from these lakes between 5 to 15 years after hydroelectric development.

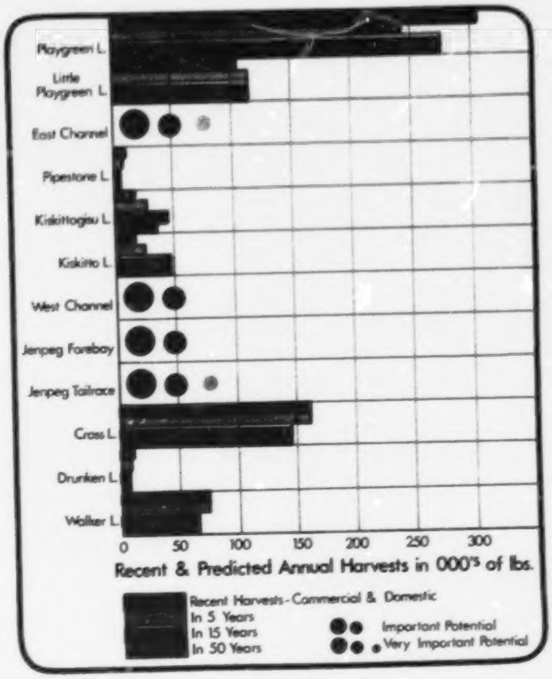


Fig. 6-16
Predicted Annual Fish Harvest Potentials in the Outlet Lakes Area Following Hydroelectric Development.

Predicted potentials are shown in Fig. 6-16. A slight overall decline in harvest potential is anticipated during the first 5 years of operation, due to an expected drop in productivity in Playgreen Lake. After 15 years, however, harvest potentials for the present commercial species are expected to slightly exceed present yields, due mainly to expected increases in productivity in Kiskittogisu and Kiskitto lakes. The estimates of future harvest are based on the assumption that present yields represent present harvest capacities, however, present yields are perhaps two to three times less than their estimated potential. This distinction has little significance in the evaluation because of the minor anticipated overall impact on productivity from hydroelectric development in the Outlet Lakes.

## WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE

Lakeshores and riverbanks in the Outlet Lakes area are used by wildlife in varying degrees; use being a function of the shape and character of the substrate, vegetation, and habitat requirements of the wildlife species involved. As described in a previous section, the regulation of discharges from Lake Winnipeg will change the shape of shorelines and the vegetation species along these shorelines. Changes in the physical environment will affect wildlife populations in the Outlet Lakes area.

Data were gathered on the Outlet Lakes through the processes of aerial surveys of waterfowl and ungulates, and assimilation of data from reports, interviews, and personal observations. The waterfowl survey was conducted in late September, 1972, and the moose survey was flown in October of the same year (Figs. 6-17 and 6-18). During these surveys, information was gathered on the relationship between wildlife populations and shoreline types.

Data on fur harvests and trappers in communities affected by hydroelectric development were taken from information supplied by the Socioeconomic team of the Study.

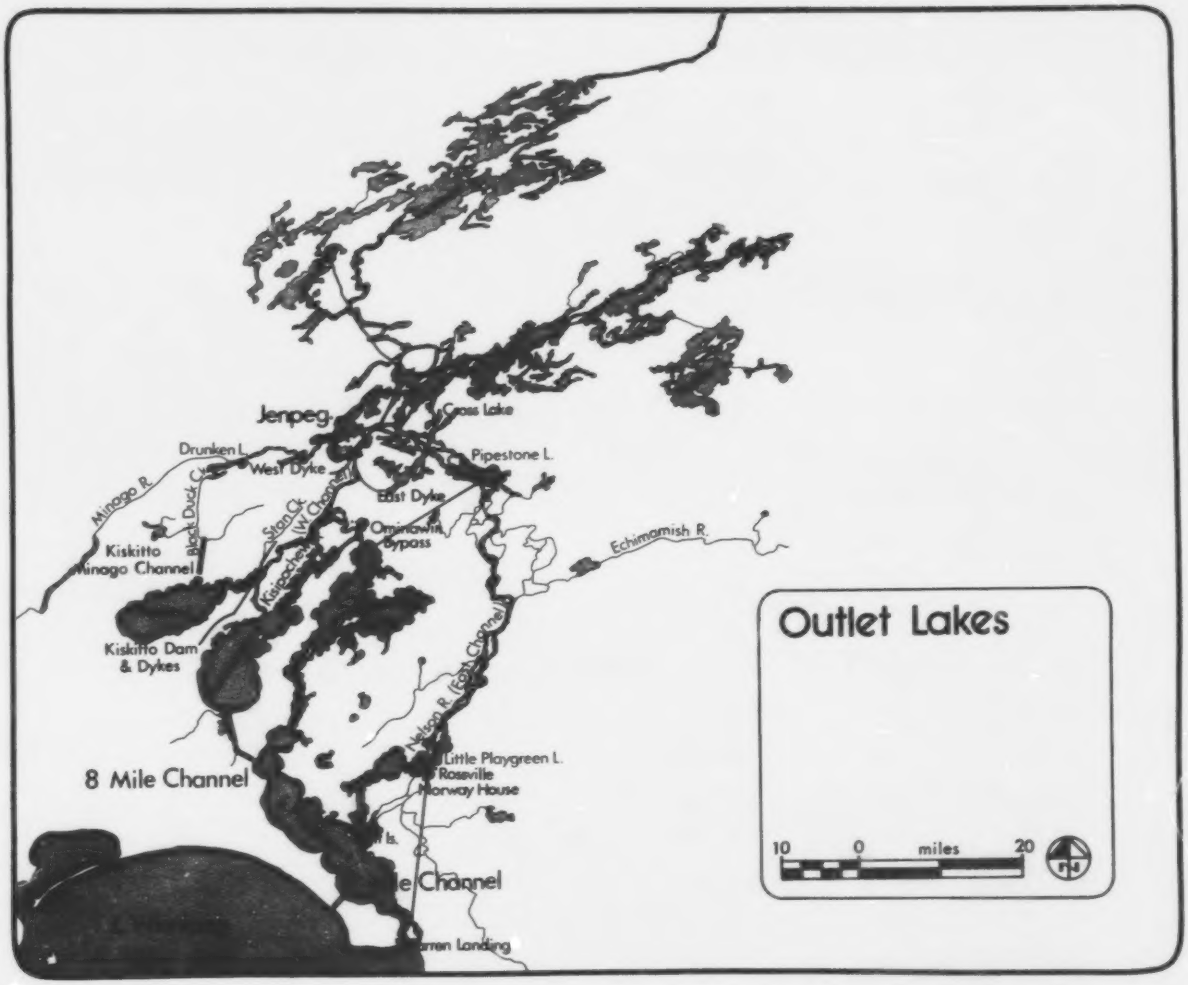

Jenpeg
Cross Lake
Drunken L.
West Dyke
Pipestone L.
Minago R.
Black Duck Cr.
Stan Cr.
(W. Channel)
East Dyke
Ominawin Bypass
Echimamish R.
Kiskitto
Minago Channel
Kisipachew
Kiskitto Dam
& Dykes
Nelson R. (East Channel)
Little Playgreen L.
Roseville
Norway House
8 Mile Channel
Is.
le Channel
Landing
Outlet Lakes
10
0
miles
20

Fig. 6-17. Aerial Survey of Waterfowl Staging Areas, Outlet Lakes, 1972.

## WILDLIFE HABITAT AND POPULATIONS

Ungulates - The area supports or has supported a number of ungulate species: white-tailed deer (*Odocoileus virginianus*), moose (*Alces alces*), woodland caribou (*Rangifer tarandus caribou*), and barren-ground caribou (*Rangifer tarandus groenlandicus*). The two most abundant species are the moose and woodland caribou.

While moose and woodland caribou have distinctive habitat requirements, they are often found in the same forest type. Shorelines which provide the best moose habitat are usually bordered by marshes and have a low backshore area with good growth of willow and other browse species. Cross Lake, with over 650 miles of suitable shoreline, the West Channel, and the north basin of Playgreen Lake support the largest areas of prime moose habitat. Surveys in late November, 1972, revealed a minimum density of 0.3 moose per square mile in the Outlet Lakes area based on animals observed on transect. Actual densities could be two or three times that large.

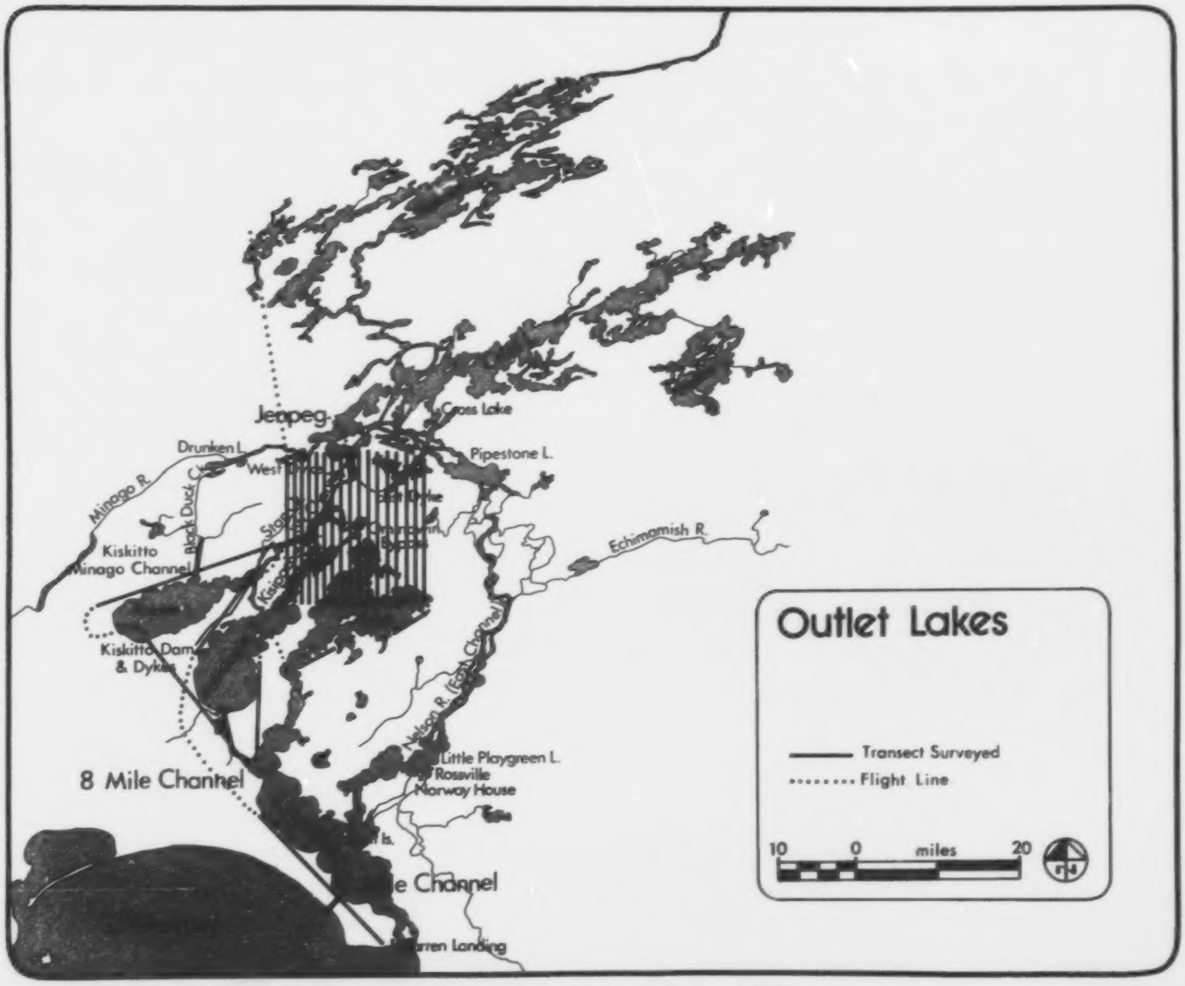

Outlet Lakes
Jenpeg
Cross Lake
Drunken L.
West
Pipestone L.
Minago R.
Black Duck Cr.
Kiskitto Minago Channel
Echimamish R.
Kiskitto Dam & Dykes
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
8 Mile Channel
Channel
Warren Landing
Transect Surveyed
Flight Line
10 0 miles 20

Fig. 6-18. Aerial Survey of Moose, Outlet Lakes, 1972.

No surveys for woodland caribou were undertaken in the Outlet Lakes; however, Canada Land Inventory data indicate that the south-eastern part of the Outlet Lakes area with its extensive coniferous forest cover comprises good caribou habitat. In addition, islands in Kiskitto, Kiskittogisu and Playgreen lakes are apparently used for calving from early spring (April) to early summer (late June). Shoreline areas are generally not critical to caribou in winter.

It has been estimated that the total population of woodland caribou in Manitoba is 5000. Indications are that two herds exist in the Outlet Lakes region; the Norway House herd and the Cross lake herd. Densities in the Outlet Lakes area are rated as light but no population estimates are available.

Furbearers - Furbearers are found throughout the area and most are closely associated with the land-water ecotone. Beaver (*Castor canadensis*), and mink (*Mustela vison*), provide the bulk of trappers' returns in the Outlet Lakes, followed by lynx (*Lynx canadensis*) and muskrat (*Ondatra zibethicus*). Several other species, including red squirrel (*Tamiasciurus hudsonicus*) and ermine (*Mustela erminea*), are also trapped but form only a small part of the total trapping return.

Beaver habitat is mainly on smaller creeks and channels but some lodges are on lakeshores. The most important localities for beaver in terms of shoreline are Cross Lake, the East Channel and the Upper Nelson River. The most important areas for mink are Cross Lake, West Channel, north basin of Playgreen Lake and the East Channel.

Muskrat habitat is closely related to shoreline vegetation. The water regime is important to muskrat production and welfare. Greatly raised water levels or fluctuations at unusual times of the year may kill vegetation important to this furbearer. Reduced water levels during winter may kill muskrats if levels are low enough to freeze to the bottom. Winter levels in excess of 4 ft in marshes are probably required to prevent this condition, referred to as "freeze out".

Lynx are found throughout the Outlet Lakes area. The lynx requires a large land area for its existence and roams throughout all forest types and along shorelines. Its major prey species is the snowshoe hare (*Lepus americanus*), and therefore deciduous vegetation important to the hare is also important to lynx. Other furbearers are present in the area, including weasel (*Mustela nivalis*), fox (*Vulpes vulpes*), red squirrel, marten (*Martes americana*), wolverine (*Gulo luscus*), and wolf (*Canis lupis*). Most require a land base but are also associated to some degree with water-land ecotones. Their requirements are important from an ecological point of view but they contribute little towards fur production within the Outlet Lakes area, and therefore were not studied.

The wildlife study did not estimate the total population of furbearers by species that will be lost.

Birds - A number of species occurring in or near the Outlet Lakes area can be tentatively assigned high economic or aesthetic values or are regarded as being rare or endangered. Economically valuable species include most waterfowl while those of particular aesthetic interest include the colonial fish eating species and certain birds of prey. Species considered endangered in Manitoba include the white pelican (*Pelecanus erythrorhynhos*), double-crested cormorant (*Phalacrocorax auritus*), bald eagle (*Haliaeetus leucocephalus*), and osprey (*Pandion haliaetus*), while the greater sandhill crane (*Grus canadensis tabida*) is considered rare.

Significant numbers of Canada geese (*Branta canadensis*) and ducks, predominately lesser scaup (*Aythya affinis*), use the Outlet Lakes in the fall (Fig. 6-19). The greatest numbers of Canada geese observed during the fall survey were on Cross Lake (1100) and Duck Lake (400). Several species of waterfowl also breed in the area, but numbers have not been reported as large. Canada Land Inventory rates no area as being important for production. Canada geese, the only species of goose breeding in the area, occur regularly.

Common dabbling ducks of the Outlet Lakes area include the mallard (*Anas platyrhynchos*), gadwall (*Anas strepera*), pintail (*Anas acuta*), green-winged teal (*Anas carolinensis*), American widgeon (*Mareca americana*), and shoveler (*Spatula clypeata*). These species are apparently not numerous during the breeding season although substantial concentrations were observed during fall migration. Mallards are the most commonly reported species during summer.

Diving ducks reported in the Outlet Lakes area include the ring-necked (*Aythya collaris*), lesser scaup, common goldeneye (*Bucephala clangula*), and several species of merganser (*Mergus* spp.). Lesser scaup are the most abundant species and have been reported breeding in large numbers. During fall migration, large concentrations of scaup (presumably lesser) were observed on Cross Lake and Playgreen Lake.

No breeding whistling swans (*Olor columbianus*) occur although migrants from Arctic regions were observed during the fall period. Fall migrants were most numerous along the east shore of Kiskittogisu Lake and the west shore of the south basin of Playgreen Lake and occurred sporadically elsewhere. Numbers were low.

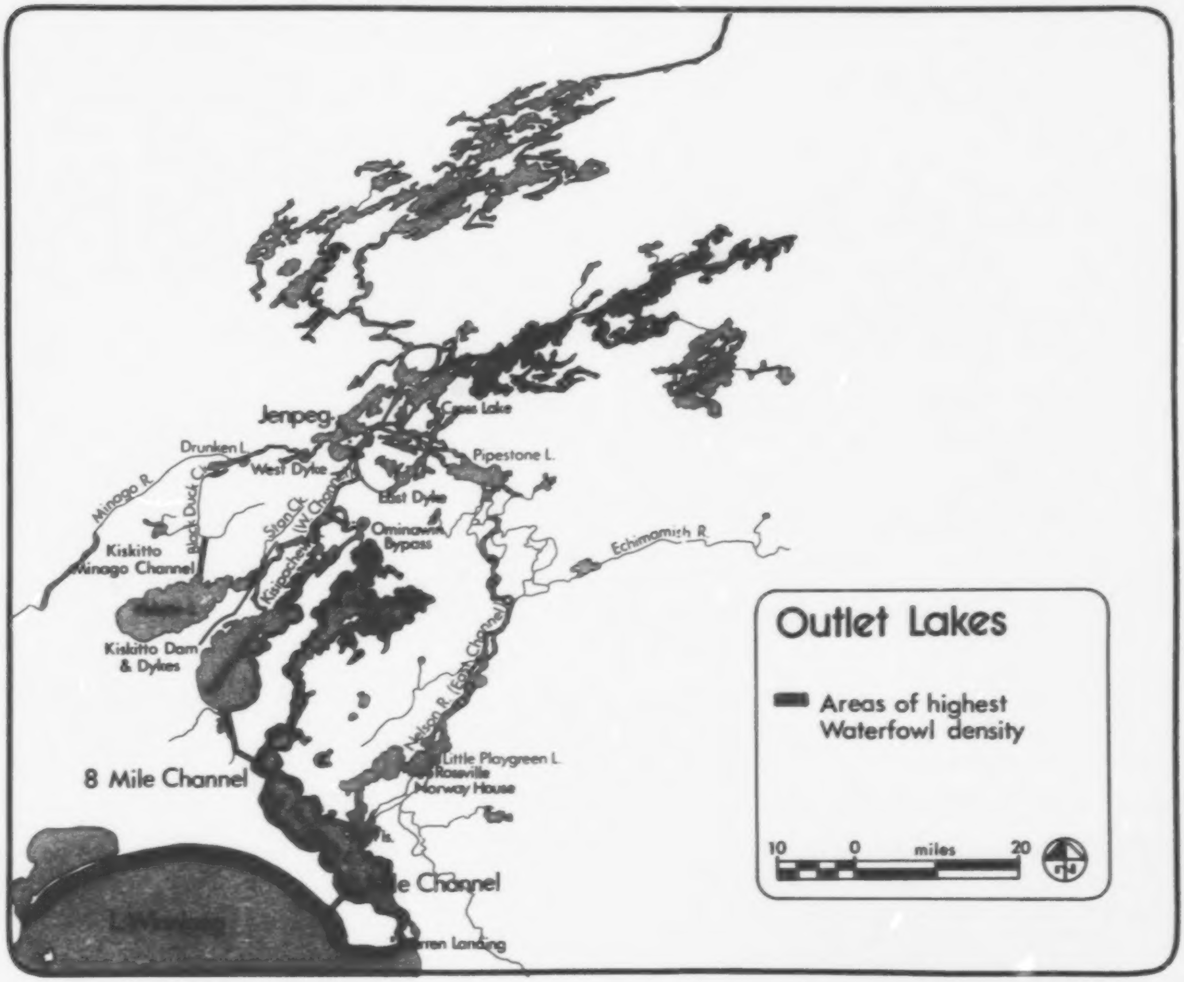
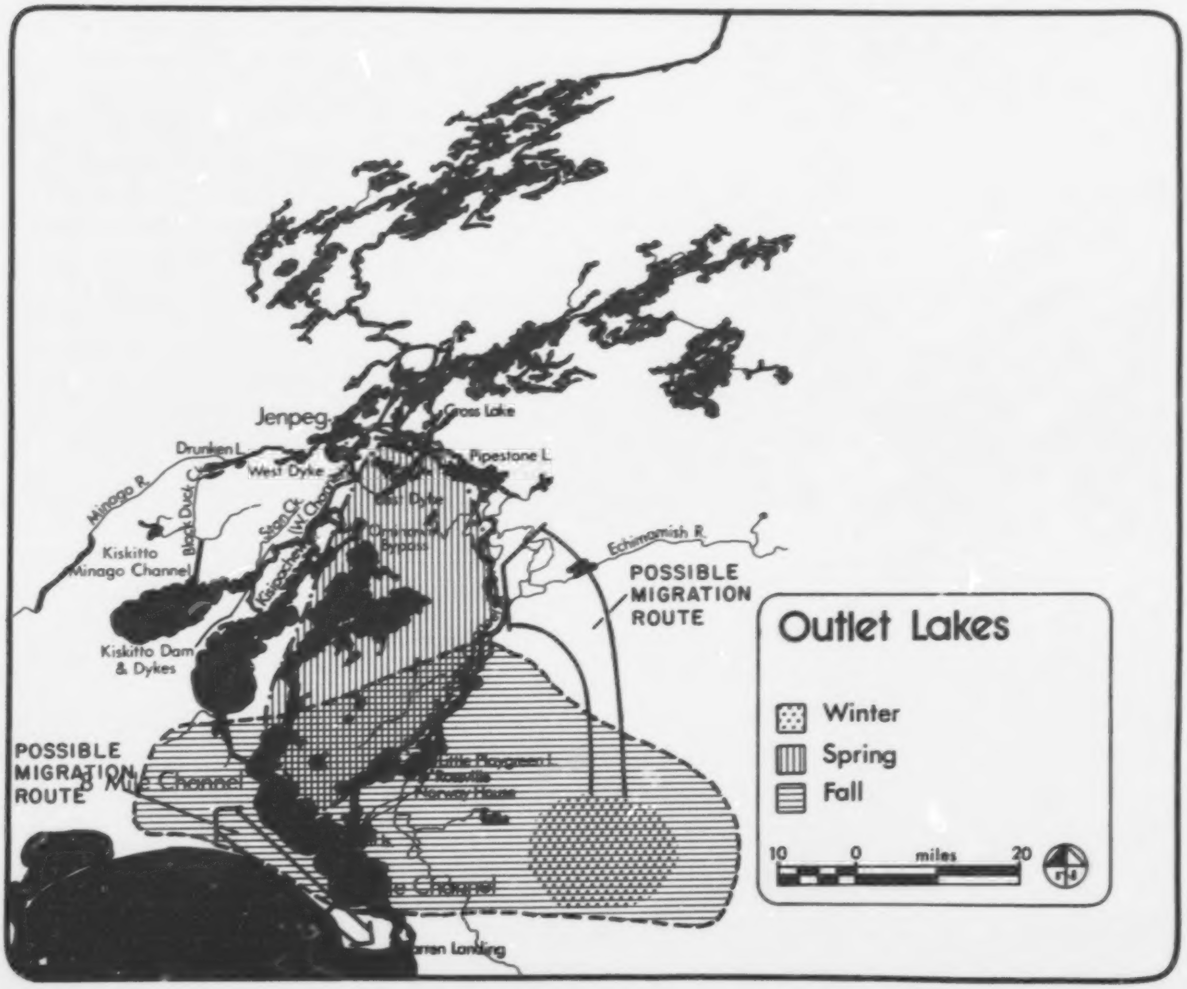

Jenpeg
Cross Lake
Drunken L.
West Dyke
Pipestone L.
Minago R.
Black Duck Cr.
East Dyke
Sian Ck.
(W. Channel)
Ominawin Bypass
Echimamish R.
Kiskitto Minago Channel
Kisipachewuk
Kiskitto Dam & Dykes
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
8 Mile Channel
Is.
le Channel
Warren Landing
L. Winnipeg
Outlet Lakes
Areas of highest Waterfowl density
10
0
miles
20

Fig. 6-19. Areas of Highest Waterfowl Density in the Outlet Lakes, Fall, 1972.

EFFECT ON WILDLIFE HABITAT AND POPULATIONS - It is anticipated that some loss of currently favourable wildlife habitat will occur with the regulation of Lake Winnipeg; there will be a subsequent effect on base populations. Loss of habitat will result from higher mean levels and detrimental fluctuations in these levels.

Effect on Ungulates - Based on Canada Land Inventory capability ratings, 26.3 square miles of good moose habitat and 11.1 square miles of moderate quality habitat will be lost with flooding in the West Channel. Actual aerial survey data from October, 1972, indicate that twenty moose could be lost from the base population. However, capability ratings for the area suggest a probable total loss of thirty-five to forty-eight animals. Capability of the area varies from 0.4 to 1.0 per square mile. The number of moose that could be lost in other localities due to flooding caused by regulation of Lake Winnipeg is not known because the total area to be flooded in the Outlet Lakes is not known.

It is anticipated that movements of the Cross Lake caribou herd could be affected (Fig. 6-20). Winter water releases from Jenpeg could cause weak ice and prevent certain areas in Cross Lake from completely freezing over. Potential significance of this to migration of caribou is deemed small. A possible caribou migration route could be affected by the 2-Mile Channel.


Jenpeg
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East Dyke
Ominawin Bypass
Kiskitto Minago Channel
Kisipachewuk
Echimamish R.
POSSIBLE MIGRATION ROUTE
Kiskitto Dam & Dykes
POSSIBLE MIGRATION ROUTE
8 Mile Channel
Little Playgreen L.
Rossville
Norway House
Channel
Warren Landing
Outlet Lakes
▨ Winter
▥ Spring
▤ Fall
10
0
miles
20

Fig. 6-20. Migration Pattern of Woodland Caribou in the Outlet Lakes, Manitoba.

Effect on Furbearers - Along the West Channel and the north end of Kiskittogisu Lake, aquatic furbearers, presently inhabiting shorelines that will be flooded, are expected to be displaced. Some species such as the beaver may adapt to a higher mean water level, but muskrat and others will be unable to exist until new marshes form. Mink are associated with several shoreline types along the West Channel and therefore will be affected. On Cross Lake, higher mean water levels in winter under regulated conditions will flood out muskrat and beaver houses constructed at low fall water levels. Percentage losses in populations are anticipated to be high.

Along the shores of Kiskittogisu Lake and Playgreen Lake, aquatic furbearer populations, expecially muskrat, are expected to experience freeze out in some years due to the lowering of lake levels over the winter season. House construction will be tailored to the regulated fall water level. Over the winter the lakes will be drawn down (to a maximum of 6 ft) in some years, leaving muskrat houses exposed.

Effect on Birds - Some existing marshes upstream of the Jenpeg control structure will be completely or partially flooded; however, with the reduced range of fluctuation in water levels under regulated conditions, new marshes could develop in an unknown time span. Downstream of this structure, some marshes may dry up, significantly reducing the value of these areas to waterfowl and furbearers.

Fourteen of 128 miles of shoreline along the West Channel and the north end of Kiskittogisu Lake are bordered by marsh, 8 miles of which have limited capacity to support waterfowl and 6 miles represent good marsh habitat. Much of the existing marsh will be destroyed through alternate flooding and drawdown, and the current low numbers of waterfowl using the area will be adversely affected.

Of the 48 miles of marsh along Playgreen Lake, one-half is not well developed and the other half comprises fair to good marsh habitat. Waterfowl will continue to use these areas for fall staging, but to a lesser degree.

Numerous small islands throughout Playgreen Lake will be affected. Depending upon their present elevation, some will be reduced in size, while others will be completely inundated, thus removing nesting habitat for waterfowl.

Little waterfowl breeding habitat is present along shorelines of the southern part of Kiskittogisu Lake. Only 3.5 miles of a total of 74 miles support marsh vegetation. The lake does, however, have some offshore areas and shoreline judged by Canada Land Inventory to be potentially valuable as migration staging areas. These low lying onshore and offshore areas will be alternately flooded and exposed by fluctuating water levels with detrimental effects to aquatic vegetation. Moderate numbers of migrating whistling swans, scaup, mallards and Canada geese were observed using the area in the fall of 1972; these birds could be partially displaced. Waterfowl and other birds will have difficulty using the marshes for nesting. Numerous nesting islands may be inundated.

Nesting islands in Kiskitto Lake will be flooded less often and fewer waterfowl nests will be affected by spring floods. Some stagnation and loss of desirable marsh plants may take place if the water regime is maintained within too narrow a margin.

With the regulation of discharges from Lake Winnipeg, the water regime of Cross Lake will be characterized by a high water level during winter and a low water level during summer. This should not have detrimental effects upon marsh plants and in fact may encourage their development. Ice scouring, which will occur with the regulation of discharges into Cross Lake, could, however, remove large permanent marsh plants such as bulrushes from fast flowing reaches in the western end of Cross Lake. Smaller, quickly growing species (particularly *Carex* sp.) should flourish on bottom sediments exposed during summer and may not be removed by ice. These factors will act to maintain or enhance the lake's suitability for waterfowl.

## WILDLIFE USE

Hunting - The two most abundant ungulates, moose and woodland caribou, are utilized as food by native residents and hunted to a limited extent by non-local licensed hunters.

The Outlet Lakes are within provincial Game Hunting Area 3, bounded by the Ontario border, Gillam and Grand Rapids. Between 1965 and 1972, estimated moose harvests averaged eighty-eight in Game Hunting Area 3 and seventeen in the Outlet lakes area (Fig. 6-21). Recreational moose hunting pressure is extremely light. Moose are hunted by native residents for food in a generally unrestricted manner. Most animals are taken during fall and winter when access is easier and animals are in good condition. This harvest is probably greater than that by licensed hunters. Annual allowable harvest of moose in the Outlet Lakes area could be as high as 800 animals. Less than 2 percent of that figure is currently taken by licensed hunters. An unknown number of additional moose is taken by Registered Treaty Indians.

The Outlet Lakes area provides 65 to 75 percent of the annual caribou harvest in Game Hunting Area 3. From ten to fifteen animals are reported killed each year. Registered Treaty Indians take an additional twenty animals per year near Norway House. Little is known about the distribution of animals or harvest rates in the Cross Lake area. It is possible that various islands in Cross Lake may be utilized for calving by the Cross Lake herd.

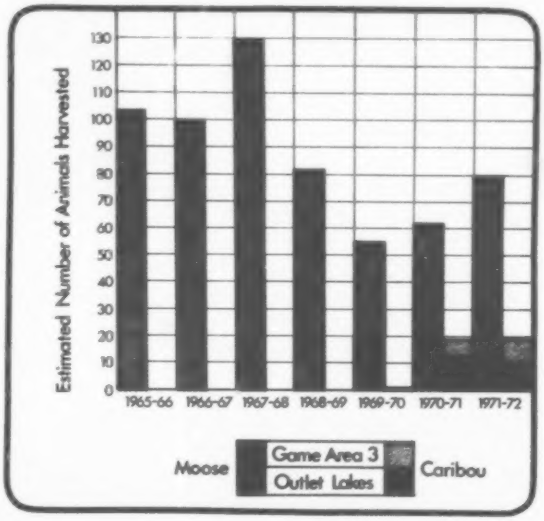


Fig. 6-21
Moose Harvest Statistics for Licensed Hunters (1965-72) and Caribou Harvest Statistics (1969-71) for the Outlet Lakes and Game Hunting Area 3.

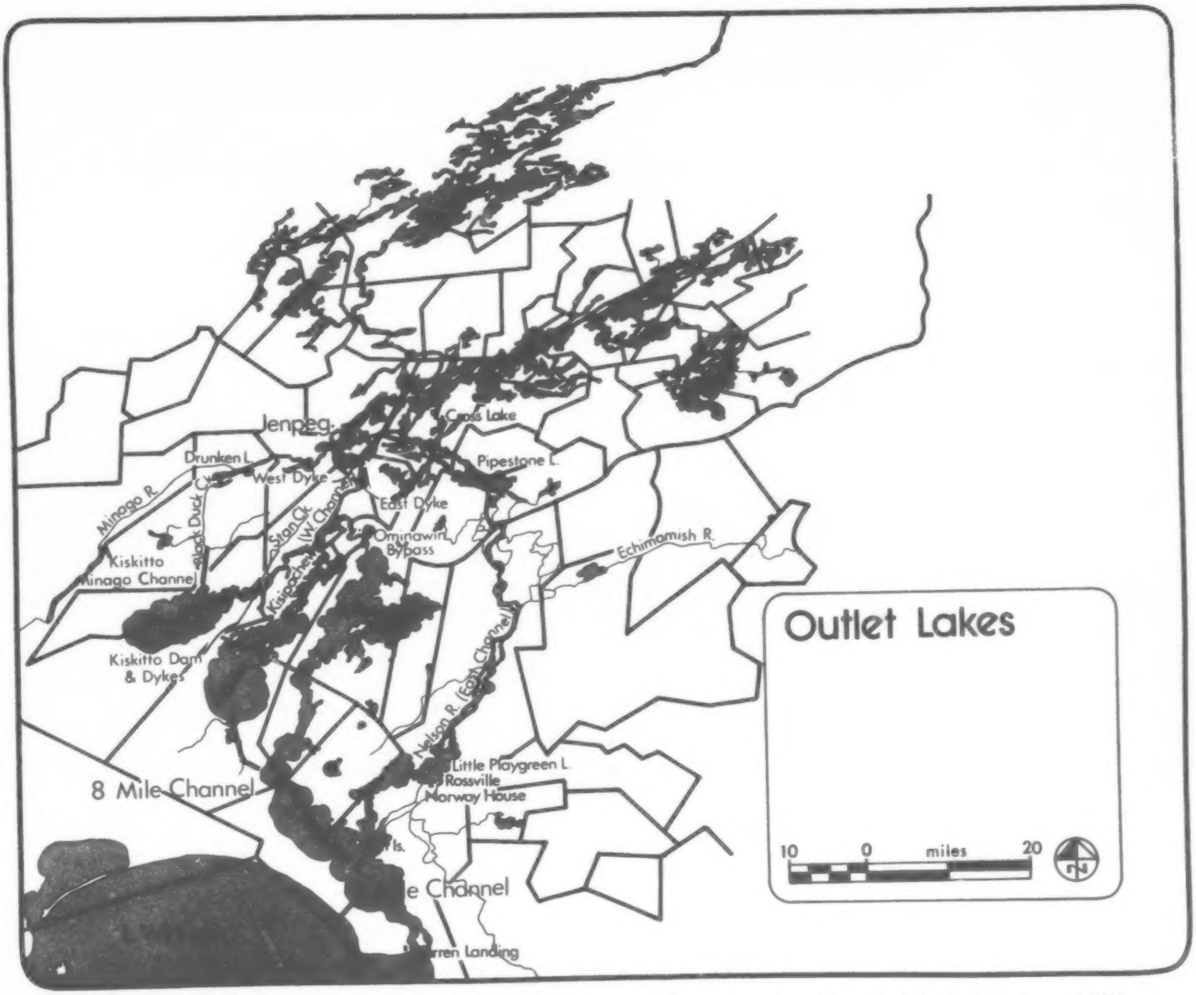
Caribou harvest data, based on a Manitoba Department of Mines, Resources and Environmental Management questionnaire for 1969-1971, are presented in Fig. 6-21. Kills in the Outlet Lakes area as a percentage of total in Game Hunting Area 3 were 100 percent in 1969; 68 percent in 1970, and 73 percent in 1971.

Waterfowl harvest data are not available for the Outlet Lakes. As a result of its general inaccessibility, the Outlet Lakes area plays only a minor role in provincial waterfowl utilization. It is within Game Bird Management Unit No. 1, a vast area comprising most of the northern two-thirds of the province. During 1963, 2.9 percent of the duck harvest and 14.6 percent of the goose harvest took place within this unit. The unit was subject to only 0.8 percent of the total hunting pressure in the province. In 1965, only 0.7 percent of total hunter days were expended in this unit. Very few geese are taken in the area by licensed hunters, and licensed hunter harvest of ducks are very low. Ducks and geese are utilized to an unknown degree by non-licensed Registered Treaty Indians.

Trapping - Furbearers have provided an important part of the cash income of Norway House and Cross Lake residents. Approximately 400 trappers are registered in the two communities. The most important species are beaver, mink, muskrat and lynx which constituted 90 percent of the annual fur harvest value for 1966-71. Revenue to trappers in 1970-71 was $24,000 for Cross Lake, and $31,000 for Norway House. Muskrats and mink are the two species most closely related to shoreline vegetation. The water regime is important to muskrat production. Raised water levels or unusual fluctuations may kill vegetation important to muskrats and lower levels in winter may cause freeze outs. Beaver may adjust to gradually increased water levels. Loss of fur production will be greatest on Cross Lake, the West Channel, and the East Channel. Significant short and possibly long-term losses of income from trapping will occur in the West Channel, Cross Lake, Kiskittogisu lake, Playgreen Lake and the East Channel. At Cross Lake, twenty registered trapping blocks and possibly another seven will be affected. Approximately 120 trappers could lose some income at Cross Lake. Income losses of lesser magnitudes will occur in almost all other areas.

For the 400 trappers at Norway House and Cross Lake who operate traplines, beaver and mink provide the bulk of returns, followed by muskrat and lynx. Red squirrel and ermine are also trapped, but form a negligible part of the total return.

Furbearers in northern Manitoba are harvested under a registered trapline system (Fig. 6-22). Most trapping blocks are assigned to an individual and large community traplines are used by trappers who do not have their own lines. Portions of the Norway House and Cross Lake registered trapline sections are in the Outlet Lakes area. The Norway House community line (No. 1) averages eighty to eighty-five trappers while the Cross Lake line (No. 56) averages fifty trappers per year. Individual lines average 2.3 trappers (including helpers) per year.


Outlet Lakes
Jenpeg
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Pipestone L.
Minago R.
Black Duck Cr.
Stan Cr.
(W. Channel)
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Ominawin Bypass
Echimamish R.
Kiskitto
Minago Channel
Kisipachew
Kiskitto Dam
& Dykes
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
8 Mile Channel
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Fig. 6-22. Registered Trapline Sections and Blocks in the Outlet Lakes, 1972.

Due to the time differential in pelt priming of species, trapping for individual species is restricted to certain periods of the year, e.g., muskrats - spring and fall; mink - early winter; and lynx - mid-winter. The trapping season begins in October-November and continues until May. Pelts are usually sold through local fur dealers.

Fur production data for the four most important furbearers - beaver, mink, muskrat, and lynx - are presented in Fig. 6-23. Dollar returns, by species and in total, fluctuate substantially from one year to another. Fluctuations are basically controlled by world market values rather than animal populations.

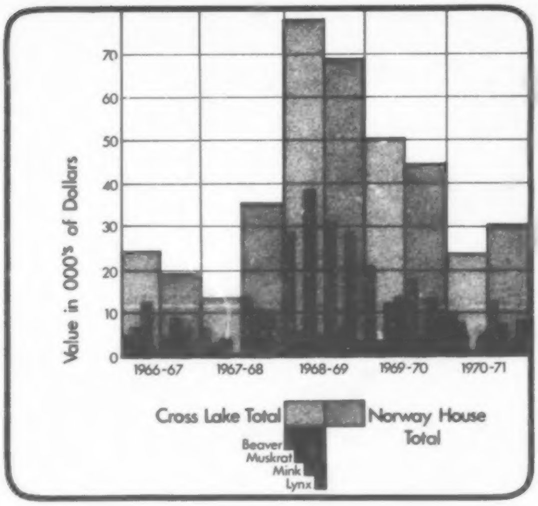


Fig. 6-23.
Outlet Lakes Value of Fur Returns From Major Species, 1966-67 to 1970-71.

The provincial government is expanding its role in fur management and has initiated several new programs; these include research; socioeconomic studies into the needs of trappers; and the organization and education of trappers. These programs are designed to encourage harvesting and to increase the biological productivity of furbearers.

EFFECT ON WILDLIFE USE - The effect of the hydroelectric project on hunting in the Outlet Lakes is not expected to be substantial. However, the effect on some furbearers could result in partial or complete loss of trapping income on some traplines.

Effect on Hunting - Inundation of the forebay area could remove as many as forty-eight moose from the estimated base population of 4000 in the Outlet Lakes area (6000 square miles). Opening of the all-weather access roads, constructed by Manitoba Hydro, in the Outlet Lakes area to the public will result in increased moose harvests by licensed hunters and provide additional viewing opportunities. Utilization of the Outlet Lakes area by licensed hunters and native people is also anticipated to increase and harvests of big game populations could exceed 20 percent of the standing crop at specific sites. Improved access will provide increased opportunity for utilization of wildlife resources; overharvest by licensed non-local hunters and by native people is expected near settlements, construction camps and along roads.

Greater harvest of waterfowl will occur when access roads are opened to the public. Since current rates of waterfowl utilization are low for both licensed hunters and Registered Treaty Indians, increases will not likely be detrimental.

Effect on Trapping - It is anticipated that twenty-five Cross Lake registered trapping blocks will be affected by the hydroelectric project. Over the period 1967-68 to 1972-73, the average annual return from these blocks was $14,252. Beaver and muskrat production combined, accounted for approximately 45 percent of the gross value of production. Mink production formed 30 percent of the gross value. It is anticipated that some of the displaced beaver and muskrat will survive and become established at higher elevations after the initial disruption. However, due to the special operating conditions in effect during November and December at Jenpeg, population losses will be incurred every year and overall productivity will be well below current levels. Mink will be less affected but there will be some long-term reduction in populations because muskrat, the minks' main food supply, will be reduced in numbers.

In addition, increased winter flows through Cross Lake may be detrimental to the formation of stable ice cover and this will make shoreline trapping hazardous. Therefore, fur harvests are expected to decline substantially.

Nine Norway House registered trapping blocks are expected to be affected by the Lake Winnipeg regulation project. These blocks are numbers 16, 18, 25, 26, 28, 31, 36, 39 and 1 (Fig. 6-22). The average annual gross value of production from these blocks over the period 1967-68 to 1972-73 was $1506 per trapping block. With the exception of blocks 25, 31, 36 and 39 (Fig. 6-22), the effect on these blocks is not anticipated to be severe. These trapping blocks are in areas where construction activities for the hydroelectric project have focused. Trappers using these blocks have experienced some disruption in access and some losses in harvest attributed to the construction activities.

## FOREST RESOURCES AND FORESTRY

With the regulation of Lake Winnipeg, there will be a loss of forest resources due to flooding, channel excavation, and the clearing of the Jenpeg forebay by Manitoba Hydro. The Forest Inventory Section, Manitoba Department of Mines, Resources and Environmental Management, determined the area and the forestry volume losses, and assessed the implication of these losses in terms of the forestry potential of this area. Land areas and forest volumes were classified, measured, and analysed on the basis of standard forest inventory procedures used by the provincial government.

FOREST RESOURCES - The province is divided into forest Management Units in order to facilitate systematic removal of products and sustained yield of the resources. The Outlet lakes area lies within the Boreal Forest region. Black spruce and tamarack predominate in most forest communities; jack pine, trembling aspen and white spruce occur less frequently. Along lakes and rivers, mixed stands of black and white spruce are common. As indicated above, the construction and operation of regulatory works for Lake Winnipeg will cause a loss of forest resources in the Outlet Lakes area due to flooding, channel excavation, and the timber clearing program undertaken by Manitoba Hydro. Losses will occur in forest Management Units 82 and 83.

## EFFECT ON FOREST RESOURCES

Effect of Jenpeg - The Jenpeg forebay is the area along the West Channel between Jenpeg and Kisipachewak Rapids. This area has been contour mapped and the 715 ft elevation contour has been designated as the boundary of inundation with regulation. Based on this boundary, 21,821 acres of existing land surface will be inundated in this portion of the West Channel. Non-productive forest covers 9105 acres, 937 acres have no forest cover, and 11,779 acres are timber covered. Softwoods such as jack pine, white spruce, black spruce, and balsam fir cover 9097 acres and hardwoods cover 2682 acres.

It is estimated that this area contains 11,171,000 cubic feet of gross merchantable softwood and 4,798,000 cubic feet of gross merchantable hardwood. Gross merchantable is a volume measure of all tree species with diameters of 3.6 inches and larger, measured 4.5 ft above ground level. The net operable volume, or the volume of an area which has over 800 cubic feet of timber per acre minus expected and known losses in volume due to decay, damage and distribution of stands, that will be lost is 4,713,000 cubic feet with spruce forming 4,120,000 cubic feet of this volume.

The timber clearing program implemented by Manitoba Hydro under the guidance of the Manitoba Department of Mines, Resources and Environmental Management has resulted in the removal of timber from approximately 12,000 acres of the nearly 22,000 acres of land that will be flooded along the West Channel. A relatively small amount of this timber was salvaged and sold. The major part was piled and burned. Recently developed techniques, which enable flooded timber to be salvaged, could be utilized in the remaining 10,000 acres that are expected to be flooded. However, due to high costs this would appear unlikely.

Effect on Kiskittogisu Lake - Forest resources will also be lost by the flooding of the south end of Kiskittogisu Lake. Contour mapping required for delineation of the area to be flooded is not available. Generally, the shoreline of Kiskittogisu Lake ranges from low relief at the southern end to moderate relief in the north-eastern part. The vegetation cover is typically treed-muskeg around the south end of the lake. The low relief characteristic of this area suggests that a significant area, estimated between 1.5 and 3 square miles, may be flooded.

Effect of the 2-Mile, 8-Mile and Ominawin Bypass Channels - A total gross merchantable volume of 376,000 cubic feet of timber and an existing land area of 1.7 square miles will be lost as a result of the excavation of these channels. This is equivalent to a net operable loss of 115,000 cubic feet with spruce comprising 84,000 cubic feet of this total.

The spoil excavated by the hydraulic dredges which have been used in the construction of these channels is deposited on areas adjacent to the channels. Ominawin Bypass Channel was mainly excavated by blasting and the dry materials were contained in the vicinity of the banks of the channel. The material from the dredging operations at the 8-Mile and 2-Mile Channels, a slurry of water and clay with some peat, is being deposited in designated sites called dredge spoil areas. The spoil areas for the 8-Mile Channel cover an area of approximately 50 square miles. The spoil area for the 2-Mile Channel extends 10,000 ft on both sides of the channel, however, the actual area which will be inundated with dredge spoil is smaller than the area designated for its distribution. It is estimated to be 10 square miles. An inventory of this area was not undertaken because the boundary could not be defined until after construction was completed. As stated previously, these deposits will kill all coniferous trees where clay or silt covers the trunk above the root collar. Brush such as willow and alder will generally survive by establishing new roots near the surface. However, with time, it is anticipated that this area will regenerate back to productive timberland.

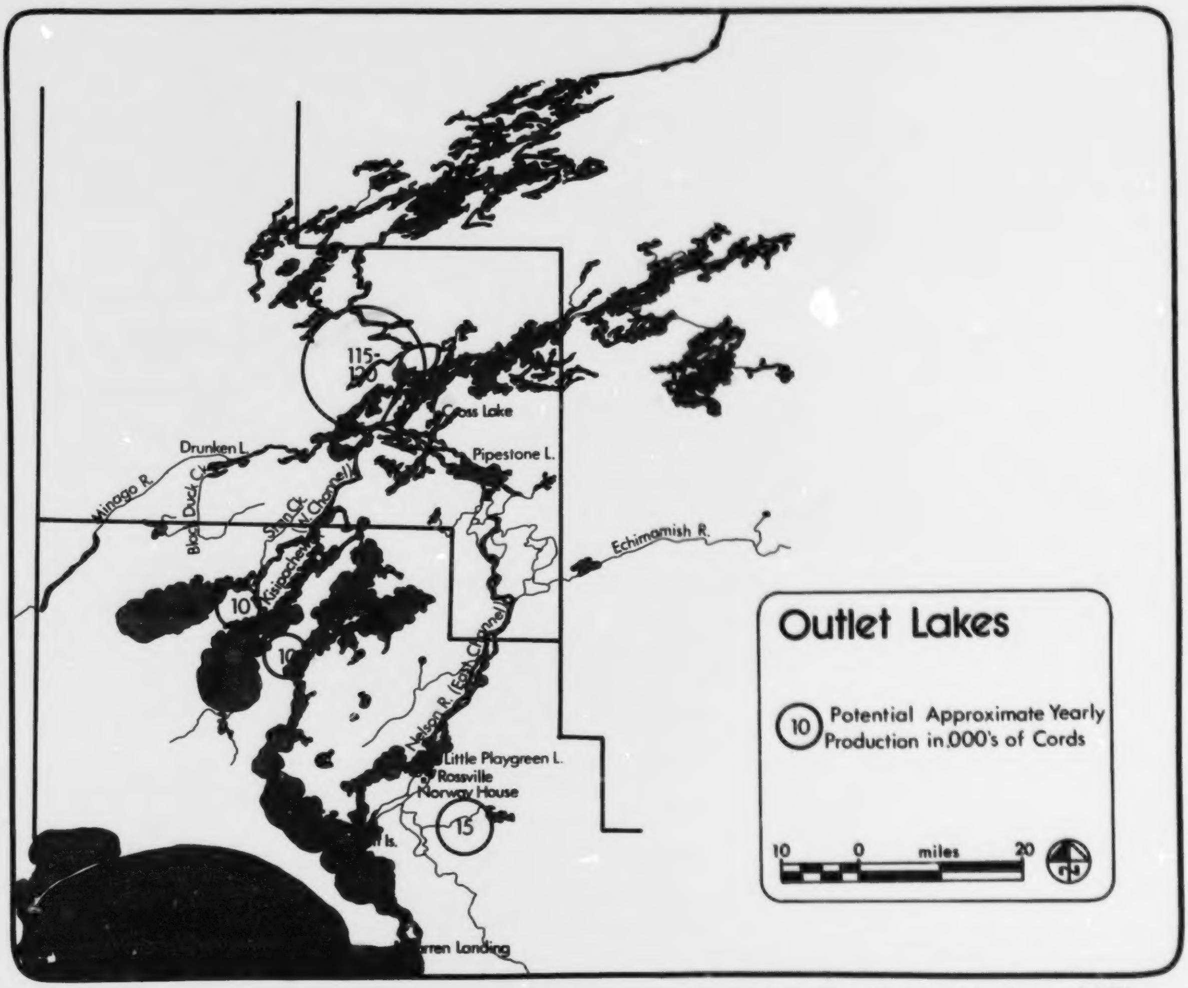
## FORESTRY

Forest Management Unit 82 - This Management Unit contains almost all of the Outlet Lakes area except for a portion of the East and West channels and Cross Lake. Total annual potential harvest is estimated at 26,000 to 27,000 cords of pulpwood. There are three distinct sub-areas (Fig. 6-24) which may potentially produce most of the forest products in this Management Unit. The first lies northwest of Kiskittogisu Lake. The second is situated between Playgreen Lake and Kiskittogisu Lake. The third sub-area is east of Norway House. Of the total yearly potential harvest, the first two sub-areas together could provide about 10,000 to 15,000 cords, while the third sub-area could provide approximately 12,000 to 17,000 cords. The present operation in the area produces approximately 5000 cords per year.

Marine Transport Limited, which has the cutting rights in this area, is under contract to the Abitibi Manitoba Paper Ltd. complex at Pine Falls, Manitoba, for cutting and transporting the pulpwood. Since Marine Transport Limited is a water based operation, the movement of pulpwood to Pine Falls takes place only in the summer when Lake Winnipeg is navigable. Some of the lumber in Management Unit 82 is used to supply local demand at Norway House where a sawmill is in operation.

Forest Management Unit 83 - Unit 83 includes all of Cross Lake and the northern portions of the East and West channels of the Nelson River. Most of Unit 83 has a marketable product although at present it is not in production. The cutting rights are held by Manitoba Forestry Resources Ltd. The total potential harvest is estimated at 115,000 to 120,000 cords per year of which about 2,000,000 board feet are expected to be used for lumber. The remainder could be used for pulpwood (Fig. 6-24).

EFFECT ON FORESTRY - While the hydroelectric development will decrease the total forest resource in the Outlet Lakes area, it may increase the actual harvest of forest products. It is expected that forestry operations will be facilitated by improved access through the Jenpeg road and by the possibility of improved barge transport from Lake Winnipeg into Kiskittogisu Lake.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Coss Lake
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Pipestone L.
Minago R.
Black Duck Ck.
Ck.
Kisipachew (W. Channel)
Echimamish R.
10
10
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
15
Is.
rren Landing
Outlet Lakes
10
Potential Approximate Yearly
Production in 000's of Cords
10
0
miles
20

Fig. 6-24. Total Annual Potential Forestry Harvest in the Outlet Lakes, 1972.

Effect on Forest Management Unit 82 - While the production potential of the Outlet Lakes will be reduced for as long as the reservoir is operated under the conditions outlined in the previous section, it is not expected that the total amount available for harvesting each year (i.e. the annual allowable cut) in Management Unit 82 will not require a timber cutting reduction. The area and volume available for harvest on an annual basis was examined for the two species which would suffer the greatest potential loss: black and white spruce. The reduction in both area and volume is 2 percent for black spruce and 9 percent for white spruce. In determining the practical annual allowable cut, a margin is allowed for losses in area and volume due to fire, new construction, and withdrawals from commercial harvesting operations. For Unit 82 a 12 percent reduction factor was used to calculate this margin; since the volume and area of spruce lost is within this margin, the practical annual allowable cut for this unit will not have to be reduced. However, if a major fire occurs within this area or if more land is withdrawn from forest production into such use as recreation, the allowable cut for the unit may have to be reduced.

As a result of the regulation project, the areas of potential production will possibly become more easily accessible. The resource to the northwest of Kiskittogisu Lake may be removed via the newly constructed Hydro access road built to service the Ominawin Bypass construction site which follows the west shore of the Nelson River as far south as the Ominawin area and connects to the Jenpeg access road. Shipment of pulpwood to The Pas may be made by all-weather road directly or by transshipment from the Jenpeg access road to rail at Pipun or Wabowden. Direct access to the potential forestry areas northwest of Kiskittogisu Lake would be provided by the construction of the Kiskitto control dam and the associated road. With the integration of a short rafting operation this land bridge at the Kiskitto dam would also facilitate removal of forestry products from the area between Kiskittogisu and Playgreen lakes. Another possibility for removal of forest products from this area would be by utilizing the 8-Mile Channel at the south end of Kiskittogisu Lake. The pulpwood could be barged from the Kiskittogisu Lake area via the 8-Mile and possibly the 2-Mile channels to Lake Winnipeg and Pine Falls. The potential production which exists in the area between Playgreen Lake and Kiskittogisu Lake may be removed by land and water in a similar manner due to the close proximity of the two sub-areas.

The pulpwood to the east of Norway House could be removed by one of three methods: by barge to Pine Falls; by truck to The Pas if a road from Jenpeg to Norway House was constructed; or by a combination of truck and rail, again to The Pas. The latter two methods would be predicated upon alteration of the present contract between Marine Transport Limited and Abitibi Manitoba Paper Ltd. to allow for shipment to The Pas as opposed to Pine Falls.

Effect on Forest Management Unit 83 - The loss in area and volume of black spruce in Forest Management Unit 83 due to the construction and operation of works to regulate Lake Winnipeg is one percent. For white spruce the area and volume loss is 9 percent. The reduction factor for Unit 83 has been calculated as 15 percent;

again the losses in area and volume for spruce fall within this margin. However, as in Unit 82, if major losses occur as a result of fire or further recreation development, the annual allowable cut for white spruce might have to be reduced.

In addition to the direct loss of forest area, it was considered that existing trees adjacent to the new shoreline along the Jenpeg forebay would be affected. A study was undertaken to investigate the reaction of existing tree cover to changed soil moisture conditions along the shore of two existing reservoirs, Grand Rapids and Kelsey. Growth rates of trees from a variety of sites were compared before and after flooding. The study was designed to gauge the effect of future flooding on the growth of trees adjacent to the new shoreline of the Jenpeg forebay. The study concluded that there would be no adverse effect on tree growth resulting from a raised lake level.

The northern portion of Unit 83 is presently serviced by the Hudson Bay line of Canadian National Railways and by Provincial Road 373 to Sipiwesk Lake. There has not been any road construction in this area as a direct result of the hydroelectric project.

The all-weather access road to Jenpeg could serve as a means of removing the forest products in the southern portion of Unit 83; if necessary, feeder roads could be constructed north and south from the Jenpeg road to provide better access to marketable timber stands.

Removal of forest products from the southern portion may be possible by barge. The control structure at Jenpeg will create a forebay of navigable depth permitting access by certain vessels to the Jenpeg site; the forebay, coupled with the Ominawin Bypass, 8-Mile and 2-Mile channels, will provide a water route south to Lake Winnipeg. However, the fact that the right to cut timber in Unit 83 is held by Manitoba Forestry Resources Ltd. whose plants are at The Pas, may preclude using this marine route.

Because of the great distance of this area from the Manitoba Forestry Resources Ltd. complex at The Pas, (a radius of approximately 160 miles) shipment of forest products by conventional land vehicles would be expensive. As a result, Manitoba Forestry Resources Ltd. have planned to use a truck with a capacity of 100 cords per load in order to cover this long distance at the lowest unit cost. Weight restrictions on provincial highways exclude this enormous vehicle from the existing network, hence construction and use of a winter road has been proposed. Crossing rights at provincial roads have been guaranteed through an agreement between Manitoba Forestry Resources Ltd. and the provincial government.

## MINERAL RESOURCES AND MINING

The Lake Winnipeg regulation project will have little effect on the mineral resources and on mining activity in the Outlet Lakes. The Geology Section, Mines Branch, Manitoba Department of Mines, Resources and Environmental Management, examined and mapped the mineral resources of the area to be flooded along the West Channel of the Nelson River. The mineral resources of this area were previously unknown and geological information would have been lost had this area not been mapped prior to flooding.

The geological survey was restricted to an examination of outcrops in the West Channel. These outcrops will be inundated when the Jenpeg structure becomes operational. The north-eastern section of Kiskitto Lake was also mapped to obtain supplementary information about the rocks of the West Channel.

MINERAL RESOURCES - The potential for mineral extraction in much of the area was found to be less than in many other regions of the province. However, there appears to be a certain amount of potential nickel resource in the area immediately to the west of the West Channel of the Nelson River (approximately 100,000 to 200,000 tons) and in the vicinity of Cross Lake community (approximately 50,000 to 100,000 tons). Potential copper deposits in the Cross Lake area could vary between 50,000 to 100,000 tons. There is also a potential gold resource on the north-central section of Ross Island (estimated at $5,000,000 to $10,000,000 in value) and in the area of Cross Lake community (estimated at $10,000,000 to $25,000,000).[6-2]

The West Channel of the Nelson River and the northeast section of Kiskitto Lake are Precambrian rock striking predominantly northeast. The rocks comprise migmatites and flaser gneiss with gabbroic intrusions.

At two locations in the West Channel northeast of Metchanais Rapids, and at six locations on Kiskitto Lake there are small gossans (ferruginous deposits filling the upper parts of mineral veins or forming a superficial cover on masses of pyrite) apparently derived from oxidation of pyrite. Another gossan was observed on the south shore of Kiskitto Lake. Twelve samples from eight of these nine gossans were assayed for copper, nickel, zinc, and gold, but the results showed that negligible amounts of each metal were present (Table 6-7).

TABLE 6-7
SUMMARY OF GOSSAN OCCURRENCES AND ASSAY RESULTS*

| Location reference number (Fig.6-25) | Location | | Description | Sample number | Weight (lbs.) | Lab number | Gold oz. per ton | Copper Percent | Nickel Percent | Zinc Percent |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.3 km northwest of Ominawin Rapids immediately south of Ross Island | 1 | Diabase dyke (1.8 m wide) in contact with pegmatite, shows fine pyrite along fracture planes | 348 | 1/8 | M5935 | Nil | 0.02 | 0.01 | 0.005 |
| 2 | West shore of West Channel, 0.5 km south of Jenpeg road | 3 | Small patch of gossan, 1 m wide, in hornblende-biotite gneiss. The gneiss strikes 030 and dips 45° SE | 410<br>410A | 1<br>1¼ | M5936<br>M5937 | 0.02<br>Nil | 0.03<br>0.05 | Trace<br>Trace | Trace<br>Trace |
| 3 | North shore of Kiskitto Lake at outlet to West Channel | 1 | Several small gossans up to 1 m wide, in amphibolite lenses in hornblende-biotite flaser gneiss. Local malachite staining is present. The gneiss strikes 075 and dips 75°SE | 331<br>331A<br>331C | 1 3/4<br>2¼<br>1½ | M5932<br>M5933<br>M5934 | Trace<br>Nil<br>0.01 | 0.10<br>0.185<br>0.19 | Trace<br>0.01<br>0.01 | 0.005<br>0.02<br>0.015 |
| 4 | South shore of Kiskitto Lake at outlet to West Channel | 3 | Several small gossan patches in a remnant of hornblende-biotite gneiss in granite (5). The gneiss cut by pegmatite, strikes 050 and dips 60° SE | 310 | | | not assayed | | | |
| 5 | Island in Kiskitto Lake 3.8 km west of West Channel | 3 | Minor gossans in inclusions of hornblende-biotite gneiss (3) in quartz monzonite (5) | 165B | 3/4 | M5931 | Trace | 0.018 | Trace | Trace |
| 6 | South Shore of Kiskitto Lake 5 km west of outlet to West Channel | 3 | Small patches of gossan in lenses of hornblende-biotite gneiss intruded by quartz monzonite. The gneiss strikes 050 and dips vertically | 160B | 4¼ | M5930 | Nil | 0.04 | Trace | 0.02 |
| 7 | South shore of Kiskitto Lake, 5.5 km west of outlet to West Channel | 2 | 3 m wide gossan zone, exposed for about 40 m along strike before passing under the lake. The host rocks are tonalitic (2) and hornblende-biotite gneisses (3), intruded by aboundant pegmatitic granite | 141S<br>141N | 2¼<br>2 | M5927<br>M5928 | Nil<br>Nil | 0.01<br>0.065 | 0.005<br>Trace | 0.01<br>0.005 |
| 8 | South shore Kiskitto Lake, 6 km west of outlet to West Channel | 2 | Small gossan in tonalitic gneiss (2), intruded by pegmatitic granite (5) | 142 | 1 3/4 | M5929 | Nil | 0.012 | Trace | 0.005 |
| 9 | South shore Kiskitto Lake 300 m south of map-boundary | 3 | 1.8 m wide gossan zone in hornblende-biotite gneiss, striking 080 and dipping 70°S, cut by minor diabase and pegmatite dykes | 135 | 2 | M5926 | Nil | 0.008 | 0.005 | 0.01 |

* *Assays provided by Mines Branch Analytical Laboratory, Manitoba Department of Mines, Resources and Environmental Management, Winnipeg.*

EFFECT ON MINERAL RESOURCES - The hydroelectric project will not reduce the mineral resources of the Outlet Lakes area even though some resources will be flooded. Mapping the area prior to flooding has ensured that geological information will not be lost.

MINING - Unlike other regions of northern Manitoba, the Outlet Lakes area has no extensive mining activity. The closest productive mine is the Falconbridge nickel mining operation at Manibridge which is in the vicinity of the town of Wabowden.

EFFECT ON MINING - Since the operation at Manibridge is at the periphery of the Outlet Lakes area and is far removed from the hydroelectric development, neither a beneficial nor a detrimental effect is foreseen as a result of the development. In addition, the speculative nature of mining activity makes it difficult to assess the prospects of mineral development and potential mineral exports. Any assessment of the possibility of mineral discoveries and the effect of the hydroelectric development on mining can only be made subsequent to a substantial discovery in the area.

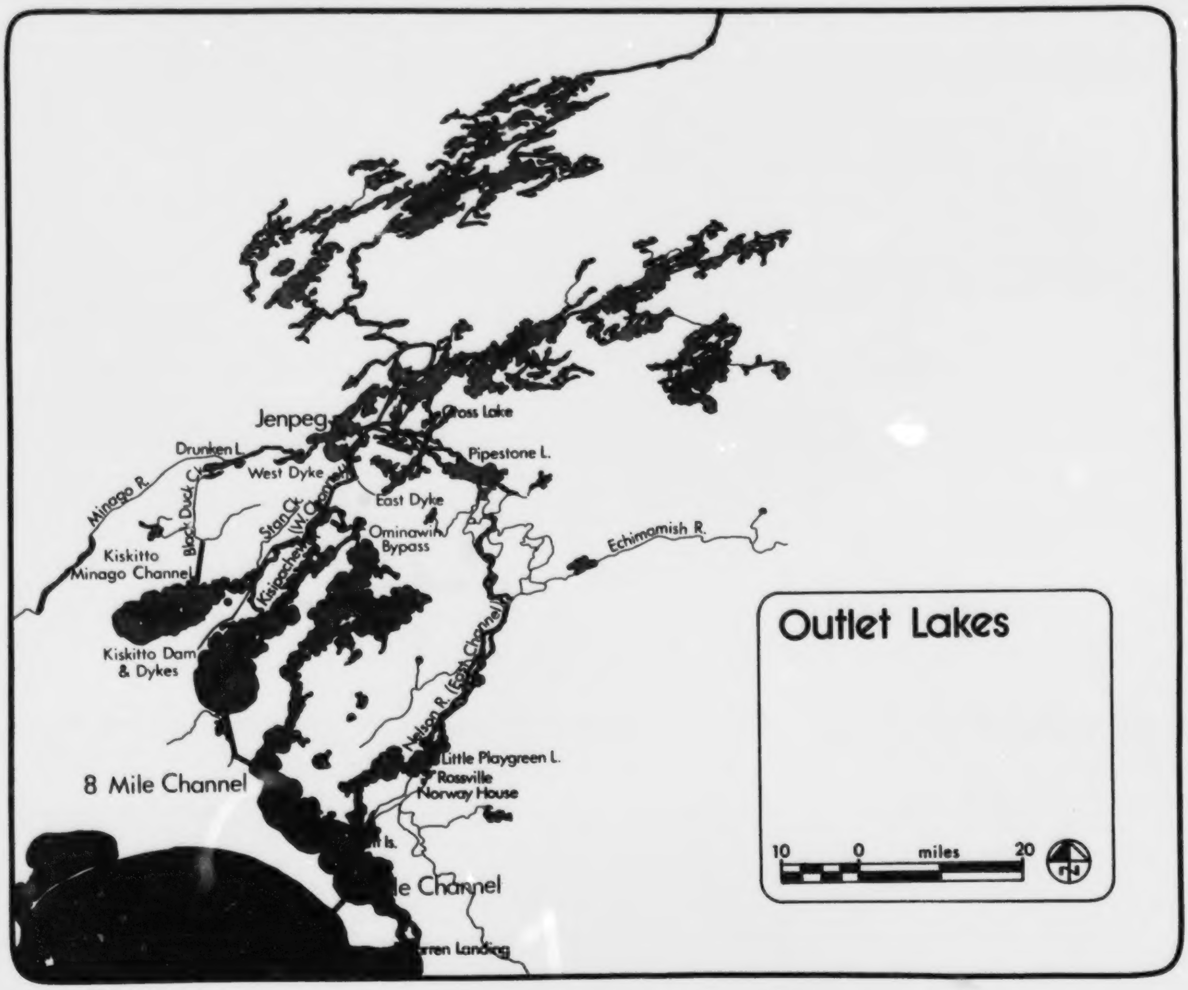

Jenpeg
Cross Lake
Drunken L.
Pipestone L.
West Dyke
Minago R.
Black Duck Cr.
Stan Cr.
(W. Channel)
East Dyke
Ominawin Bypass
Echimamish R.
Kiskitto Minago Channel
Kisipachewuk
Outlet Lakes
Kiskitto Dam & Dykes
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
8 Mile Channel
10
0
miles
20
ls.
le Channel
rren Landing

Fig. 6-25. Location of Reference Numbers for the Sample Survey of Gossan Zones, Outlet Lakes, 1972.

## OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION

Very little is known about the outdoor recreation potential in most of the Outlet Lakes area that will be influenced by the regulation of Lake Winnipeg. In order to assess the effect of the hydroelectric project, the Parks Branch, Manitoba Department of Tourism, Recreation and Cultural Affairs, estimated the area's potential use under conditions before regulation and after regulation. Assessment of the effects of Lake Winnipeg regulation on recreation potential in the Outlet Lakes area was limited to an examination of the effects on localities with physical characteristics which might provide suitable sites for outdoor recreation. No facilities for outdoor recreation exist in the Outlet Lakes area and its use for outdoor recreation purposes has been limited because access, prior to construction of the road to Jenpeg from Provincial Road 391 via Provincial Road 373, was difficult. The analysis focuses on effects the regulation project is anticipated to have on potential sites for outdoor recreation.

The methodology employed was to establish a list of sites which have opportunities for outdoor recreation based on the assumption that the Lake Winnipeg regulation project would not be undertaken. A second list was then drawn up based on the assumption that the Lake Winnipeg regulation project would be undertaken. The lists were based on knowledge of existing recreation resource uses and facilities within the province, and on the existing policy for recreation development in northern Manitoba laid down by the Parks Branch, Manitoba Department of Tourism, Recreation and Cultural Affairs. This policy provides that if access is available to an area and use is being made of it, limited facilities will be provided if warranted. No access roads will be developed solely to provide for a recreation experience unless an intense need is demonstrated or pressure exerted. No intensive-use facilities will be provided unless the area supplies a unique recreation experience.

Examination of the physical characteristics of the shorelines in the Outlet Lakes indicated that opportunities for highly intensive outdoor recreation use do not exist with or without the regulation project. Canoeing will possibly be the main recreation use of this area. The area's shorelines and beaches are suited to low intensity recreation use based on wilderness camping, canoeing, hunting, fishing, wildlife viewing and photography. The sites identified as having the relatively highest recreation potential were waters and associated shorelines of the East Channel, West Channel, Pipestone Lake, the southwest end of Cross Lake, the mouth of the Minago River, and the immediate vicinity of Jenpeg, Cross Lake and Norway House settlements. However, these areas do not have the resources to sustain high annual use by vacationers for intensive types of recreation. They are best suited to more extensive short-term uses such as white water canoeing, wilderness canoeing, camping, hunting, fishing, and to a limited extent, power boating. The intent for most areas should be to preserve the wilderness aspect; high annual intensive use is not desirable.

## OUTDOOR RECREATION RESOURCES

Recreation Potential Without the Regulation Project - The conceptual recreation design for the Outlet Lakes area without the regulation project envisages the activities and facilities listed below:

- White water canoeing on the West Channel of the Nelson River through an island-studded channel bounded by rock shorelines and scenic backshore areas typical of Precambrian shield topography.
- Canoe tripping on the fifty-mile East Channel which offers several choices of route through its multi-channeled course, and varied scenery.
- A circle canoe route using the East Channel and Playgreen Lake.
- A historic fur trade canoe route from Norway House down the East Channel to the Echimamish-Hayes River system to York Factory.
- Seasonal guiding-outfitting services at Cross Lake and Norway House to serve the canoe routes on the East and West channels between Norway House and Cross Lake.
- Road access to the area in about a decade, extending to Norway House and Cross Lake.
- Fishing and hunting up the Minago River, on Hill Lake, Drunken Lake and Black Duck Creek, and on Cross Lake around the mouth of the Minago River. A campground to serve this use could be provided near the Minago River crossing.
- Protection of the East Channel by establishing an area along both sides of the channel to preserve a pristine section of the Nelson River.
- Primitive camping and wayside facilities at Whiskey Jack Portage and Sea River Falls.
- Possibilities for development of a potential historic site complex at Norway House. This necessitates further investigations and feasibility

studies. If developed, it would require better services for visitors at Norway House.

- A motel at Cross Lake and expansion of existing accommodation facilities at Norway House.
- A suitable location for a lodge could be found in the bay on the South part of Cross Lake near Whiskey Jack Portage.
- Establishment of a campground at Norway House.

Recreation Potential With the Regulation Project - A listing was made of activities and facilities taking into account the anticipated effect of the regulation project on the recreation potential of the area. The recreation listing with regulation of Lake Winnipeg envisages the following activities and facilities:

- Manitoba Department of Highways would assume responsibility for the Jenpeg road and the Minago River crossing and eventually extend the road to Cross Lake and Norway House.
- Fishing and hunting up the Minago River, Hill Lake, Drunken Lake and Black Duck Creek, and on Cross Lake around the mouth of the Minago River. Required facilities could be provided near the Minago River crossing.
- Attraction of visitors to the Jenpeg control and generating station for viewing and sport fishing in the tailrace and forebay. This necessitates site enhancement and provision of washrooms and picnic tables for visitors.
- Canoeing and camping on the East Channel below Sea River Falls and on Pipestone Lake and the southern portion of Cross Lake bordering Ross Island. This predicates access facilities at Sea River Falls and Whiskey Jack Portage, as well as protection of the area by establishing a treed buffer zone of one-third of a mile wide along both sides of the East Channel. The zone would preserve the semi-wilderness appeal of the canoe route and protect a soon to be unique example of the Nelson River and a historic waterway.
- Possibilities for development of a potential historic site at Norway House. This necessitates further investigations and feasibility studies. If developed, it would require more visitor-oriented services at Norway House.
- The recreation potential, the possibility of vehicular access to Cross Lake, and present lack of accommodation facilities in Cross Lake settlement make a motel with cabins and a guiding and outfitting service feasible.

- Vehicular travel to Kiskitto Lake would require provision of minimal facilities such as a boat launch ramp at the Kiskitto control dam.
- The extent of potential use of the Sipiwesk Lake area for sport fishing is not known; however, the Parks Branch, Manitoba Department of Tourism, Recreation and Cultural Affairs, is developing a small campground at the vehicular access point from Provincial Road 373.

EFFECT ON OUTDOOR RECREATION RESOURCES - Implementation of the Lake Winnipeg regulation project will result in losses in certain aspects of recreation but will create other new potential activities. The recreation potential of the major portion of the area will not be affected by the project. Primary change will occur in the West Channel which will become the forebay of the Jenpeg control structure and generating station (immediately upstream from the Jenpeg structure), and on Kiskitto Lake. By comparing the two listings the following conclusions were drawn regarding the effects of the regulation project on the recreation potential of the Outlet Lakes.

The regulation project will result in the following potential gains to outdoor recreation:

- The Jenpeg control structure will create a reservoir more suitable to recreation activities associated with a lake rather than a swift flowing river; e.g., boating with craft of a deeper draught than a canoe, use of high-powered, fast boats, and still water fishing.
- An opportunity for sport fishing for northern pike and walleye in the tailrace of the Jenpeg power station will create additional recreation potential which is expected to be an important factor in attracting visitors to the area.
- The benefits to fisheries and wildlife production will enhance the recreation potential of Kiskitto Lake. This will result from regulation of Kiskitto Lake water levels by means of a control dam at its mouth, and an outlet channel and stoplog dam at Black Duck Creek. The east end of this lake will be available as a marginal recreation area, accessible from Jenpeg via a construction road.
- An opportunity exists to enhance the aesthetic appeal and recreation potential of the Jenpeg dam area by cleaning up and grassing the open areas following completion of construction so that they could be used by visitors to the dam site; placing visitor picnic and wayside facilities

and a campground near the dam; placing boat launch ramps above and below the structure.

- An opportunity exists to enhance the aesthetic appeal and recreation potential of the Jenpeg dam forebay area by completely clearing and burning all woody vegetation that would otherwise be inundated; implementing a program to remove floating debris from the reservoir; managing the reservoir levels to promote growth of desirable vegetation for wildlife along the shore.
- An opportunity exists to develop a historic site at Norway House. Construction could utilize the local labour force. Once established, the site would continue to benefit the community economically. The project would serve a useful purpose in preservation of a historic site; and provide an opportunity, through development of a tourist industry, to ameliorate social disruption which may occur as a result of the regulation project.

The regulation project will result in the following potential losses to outdoor recreation:

- Raising the water levels by damming the West Channel will eliminate the existing gradient and thus the fast water suited to white water canoeing. In addition to eliminating white water canoeing other attractions of this route will be destroyed: the numerous islands which presently enhance the channel; the several sets of rapids; and the beauty of pristine wilderness.
- This action will also cancel the high quality camping experience presently available in association with white water canoeing.
- Aesthetic quality of the reservoir area will be low if there is no clearing prior to raising the water levels (Fig. 6-26). Shoreline vegetation will be inundated and killed by the higher water levels. Aesthetic quality is an integral part of recreation experience and recreation potential. While the quality of recreation experience available and recreation potential of the area will be low without shoreline clearing, both will be increased in direct proportion to the number of miles of shoreline which are completely cleared of dead vegetation.

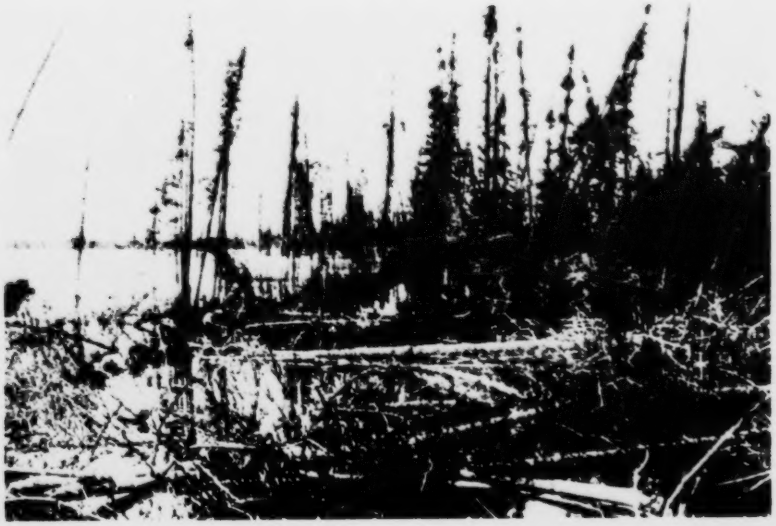


Fig. 6-26. Photograph of a Site on the Kettle Rapids Reservoir which was not Cleared Prior to Raising the Water Levels, 1973.

- A hazard to reservoir boaters will exist if shoreline vegetation is not cleared because access to the shoreline will be difficult. In areas where complete shoreline clearing is not done, selective clearing of access strips through the flooded vegetation at three-mile intervals would allow access to the shoreline, thus reducing this hazard.
- Advancing the date for accessibility to the Outlet Lakes can be regarded as having long-term costs. Northern Manitoba presently has sufficient accessible recreation land. Prudent land-use policy would advocate reserving desirable areas for use as needed. Making the Outlet Lakes area accessible by vehicle reduces the long-term reserves of recreation land.
- As participation in outdoor recreation increases, fewer and fewer areas of pristine wilderness will be available for provision of camping or canoeing experiences. In addition to loss of the West Channel for this type of experience, regulation will reduce such qualities in other parts of the Outlet Lakes. Wilderness qualities will be lost by the existence of construction camp clearings. If these are visible from a water body the wilderness experience which can be gained will be diminished. Camp debris and camp buildings left following completion of dam construction will reduce the wilderness qualities and subsequently the recreation potential. Roads, especially those constructed near or adjacent to

wilderness water, will also detract from wilderness quality. In addition, areas cleared for transmission lines, dams, dykes and surveys are not expected in a wilderness setting and detract from wilderness experiences.

- By regulating Lake Winnipeg, low water levels are possible on Cross Lake during the summer. Low water levels would inconvenience recreation boating in the southern portions of the lake between the reserve and the north shore of Ross Island. Lower water levels would also make travel by boat on Cross Lake hazardous by exposing shoals not yet charted.
- Increased accessibility will enhance hunting opportunity and pressure in the Outlet Lakes on moose, and to a lesser extent on woodland caribou and ducks, which could have dire effects on local residents dependent on hunting for meat. On the benefit side, in addition to direct satisfaction to outside hunters, opportunities exist to boost the local economy through hunting.

USE OF OUTDOOR RECREATION RESOURCES - Neither outdoor recreation development nor tourism on an organized basis exists at present in the area. Use of the area by visitors is limited and this is due to the difficult access to the area.

EFFECT ON THE USE OF OUTDOOR RECREATION RESOURCES - The regulation project has provided several new transportation facilities and services in the area. These are discussed in detail in a subsequent section of this chapter. With additional transportation facilities and services, the Outlet Lakes are more accessible and future travel to the area for outdoor recreation is expected to increase.

Use of the Outlet Lakes for outdoor recreation could be encouraged following implementation of the regulation project by installing facilities for visitors and sportsmen at Jenpeg, maintaining the Jenpeg airstrip, and by removing debris from the Jenpeg forebay area. Another possibility is the development of a historical park site at Norway House.

## ARCHAEOLOGICAL RESOURCES

With the announcement by Manitoba Hydro that the level of Southern Indian Lake would be raised as part of the Nelson River hydroelectric development program, it became evident that a large number of the archaelogical sites in the area would be destroyed. The sites that would be flooded formed an important part of Manitoba's prehistoric and historic heritage, particularly since it was estimated that the area had been occupied as long as 10,000 years ago. To determine the life patterns during the period of occupation, the government of Manitoba initiated an archaeological survey of the area to be flooded.

Intensive studies of the archaeology and prehistory of northern Manitoba began in 1969 with the formation of the Churchill Diversion Archaeological Project (now the Archaeological Research Centre). This group is a consortium representing the Manitoba Archaeological Society; The Manitoba Museum of Man and Nature; the Department of Anthropology, University of Winnipeg; and the Department of Anthropology, University of Manitoba. With funds provided by the government of Manitoba through the Parks Branch of the Department of Tourism, Recreation and Cultural Affairs, this group surveyed the area surrounding Southern Indian Lake. When the Lake Winnipeg, Churchill and Nelson Rivers Study Board and the Technical Advisory Committee reviewed the requirements for archaeological investigations for the Lake Winnipeg, Churchill and Nelson Rivers Study, they decided to focus their attention on areas that had not been surveyed and about which little information was available regarding the effect of the Lake Winnipeg regulation project. No evaluations of archaeological resources in the Outlet Lakes had been made, and only a preliminary study of the Rat-Burntwood rivers area had been carried out. The Board authorized a contract for $80,000 to the functioning Churchill Diversion Archaeological Project group to evaluate the archaeological resources in the Outlet Lakes area and in the Rat-Burntwood rivers area along the route of the Churchill River diversion. The contract was completed in April, 1973, with the submission of two reports. This section summarizes the findings for the Outlet Lakes area. The findings for the Rat-Burntwood rivers area are contained in Chapter 7.

ARCHAEOLOGICAL RESOURCES - In the case of the Outlet Lakes area, the survey evaluated the human history as represented by prehistoric and historic archaeological sites and affiliated natural history resources, and assessed the effect that the proposed regulation project might have on these resources. The time and budgetary constraints, combined with the vast area to be studied, limited the assessment in the Outlet Lakes to a sample survey of the north shore of Kiskittogisu Lake, and the West Channel of the Nelson River from the Jenpeg control structure south to Kisipachewuk Rapids (Fig. 6-27). Only a minute part of the total Outlet Lakes system was covered by the survey. Within this survey sample of fifty-nine sites, a projected sample of 330 activity centres was estimated. Approximately 30 percent of these activity centres represent recent exploration activities related to the Lake Winnipeg regulation project, and approximately 30 percent of the centres represent commercial and sport hunting and fishing, and commercial logging and mining activities throughout the late historic period. No prehistoric occupation was recorded during the field survey. The survey was supplemented by data collected through a review of the available literature on the known archaeological sites in this area. The library research was primarily concerned with data on the East Channel.

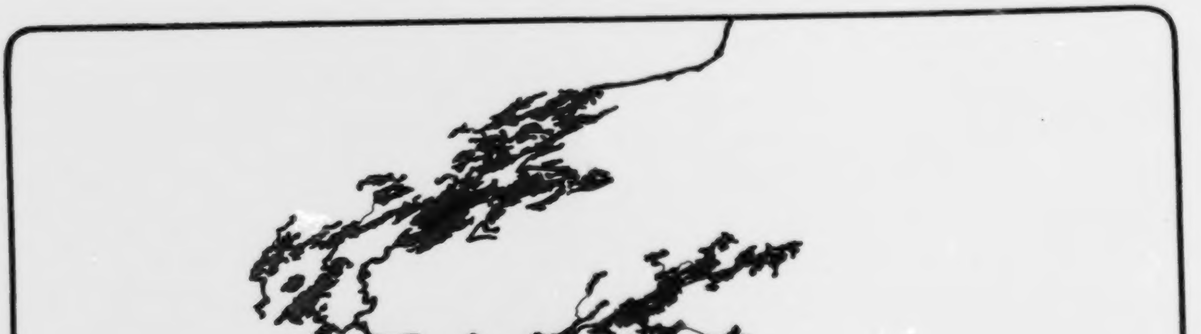

Jenpeg
Cross Lake
Drunken L.
West Dyke
Pipestone L.
Minago R.
Black Duck Cr.
Stan Cr.
East Dyke
Ominawin Bypass
Echimamish R.
Kiskitto
Minago Channel
Outlet Lakes
Kiskitto Dam & Dykes
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
8 Mile Channel
le Channel
ren Landing
10
0
miles
20

Fig. 6-27. Locations of the 1972 Archaeological Survey in the Outlet Lakes and of Recorded Archaeological Sites.

The data collected from the field survey and the data collected from the literature review were combined and used to estimate the number of archaeological sites in the Outlet Lakes area. Previous studies of the areas to the north and west of the Outlet Lakes indicate that the Outlet Lakes area was probably occupied for the past 10,000 years. Several prehistoric sites have been mentioned in the literature but have not yet been examined. These include: habitation sites at Whitefish Island, and at Norway House; stone quarries on Playgreen Lake and Pipestone Lake; and a pictograph (stone paintings of religious significance) site on a small tributary of Molson Lake. The known prehistoric evidence in the form of these special activity sites can help to reconstruct the round of activities by various prehistoric populations. The fact that no evidence of prehistoric sites or of early historic fur trade sites was found probably reflects the limitation of the field research due to crew size and time, rather than the complete dearth of prehistoric utilization.

The known prehistoric archaeological manifestations indicate habitation sites of two different prehistoric cultures - the Manitoba Phase culture or prehistoric Ojibwa (A.D. 800-1600), and the Selkirk Phase culture (prehistoric Cree) of about the same period. The Manitoba Phase, which is normally found more to the southeast, is known from two sites. The significance of this culture raises many questions since it has not been located on either Southern Indian Lake or on the Rat-Burntwood rivers.

It is believed that the Outlet Lakes area was intensively used in the early historic period. Cree and Assiniboine Indians probably used the East Channel as a route between the Boreal Forest and the Aspen Parkland. Findings of the preliminary survey of the Outlet Lakes area indicate that the area received intensive use in both the early historic period (A.D. 1600 - 1880) and the late historic period (A.D. 1880 to present). Artifacts found at the sites include a mixture of traditional native materials such as moose hide scrapers, abandoned cabins, meat racks, graves and tin cans. Five archaeological sites of traditional native hunting, trapping and fishing residences (cabins) were found, but not excavated (Fig. 6-28). These traditional cabin sites could provide important information on adaptive concepts of people who are attempting to bridge the gap between traditional and industrial lifeways. However, the sites are in danger of destruction by the new water levels eroding the clay banks upon which they are located.

The East Channel of the Nelson River was one of the main travel routes in the early historic fur trade period and during at least some of the earlier prehistoric periods. The literature review focused on the use of the East Channel as a canoe route during the early historic fur trade era when traders from the Hudson's Bay Company used it as a major route to northern trapping areas. Some of the known important geographical places are High Rock, Sugar Falls and Sea River Falls located along the East Channel. Seven fur trading posts (Fig. 6-27) were mentioned in historic records but only four of these sites have been located and none have been excavated. Of the seven fur trade posts, at least five are in the Outlet Lakes area and two are located on attached water bodies. The posts are Norway House 1 (A.D. 1814-24) at Warren Landing, Norway House II and III (A.D. 1826 to present) at the present community of Norway House, Jack River House (A.D. 1801-17), Rossville Post, Cross Lake House and Sipiwesk House.

Fig. 6-28. Photograph of the Remains of a Traditional Native Trapping and Fishing Cabin at Whiskey Jack Narrows, 1972.

EFFECT ON ARCHAEOLOGICAL RESOURCES - Many of the archaeological records are found near the edge of streams and lakes. Without regulation of Lake Winnipeg, there would be a continuous rate of site destruction due to fluctuating water levels and removal of objects by people who collect artifacts as a hobby.

With the regulation of Lake Winnipeg, the rate of site destruction is anticipated to escalate rapidly and result in the loss of archaeological records within a short period of time. With regulation, the mean water level will be higher than the modified historic mean water level. In general, it is anticipated that this higher level will result in an increase in the rate of bank and shoreline erosion in the Outlet Lakes area. The only known sites of archaeological significance which will be destroyed are two traditional native trapping and fishing cabins at Whiskey Jack Narrows (shown in Fig. 6-27 as sites UNR 204 and UNR 205). While the sites are well above the regulated water level, it is predicted that erosion of the unconsolidated clay banks on which these sites are located will increase as the mean water level rises. As indicated, the sites could provide important data on adaptive concepts of people who are bridging the traditional and industrial patterns of livelihood.

The total number of prehistoric and historic archaeological sites that will be lost is unknown, but since the flooded area will be substantially less than that on Southern Indian Lake and the Diversion Route, the archaeological data loss is expected to be relatively smaller. This does not mean that in absolute terms the loss will not be substantial.

A significant consequence of both the regulation of Lake Winnipeg and the diversion of flows from the Churchill River has been the funding of substantial archaeological research in northern Manitoba. This funding has enabled the Churchill Diversion Archaeological Project to identify, survey and excavate numerous archaeological sites within the past 4 years. These investigations have greatly expanded existing knowledge and understanding of the prehistory and history of the areas.

## TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES

Hydroelectric development in the Outlet Lakes area will modify both the existing and the potential transportation system and may affect the "modal mix" for the movement of people and goods to, from, and within the area. The Faculty of Administrative Studies, University of Manitoba, undertook a study to inventory the existing transportation infrastructure and to assess the effect of the hydroelectric development on all phases of transportation and navigation (existing and potential) in the Outlet Lakes area.

TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES - The Outlet Lakes area is located outside the main provincial land transportation network. The three major highways, Provincial Trunk Highway 10, Provincial Trunk Highway 6 and Provincial Road 391, and the Canadian National Railways line, which now provide the only land transportation link with the southern region of the province do not directly serve the Outlet Lakes area. Indirect service, however, is provided by integration of this network with other transport modes (winter truck road, tractor train and barge). The area at present has access to the southern region by the Lake Winnipeg-Playgreen Lake-Cross Lake water system. Several commercial scheduled air routes, most of which originate in Winnipeg, serve the area. In addition, charter service is available.

The Jenpeg access road was built for and is maintained by Manitoba Hydro to provide access to the construction site at Jenpeg. The road was constructed by the Manitoba Department of Highways. Manitoba Hydro constructed an eight-mile road from Jenpeg to Ominawin Bypass to provide access to the construction site at the Ominawin Channel. The control structure at Jenpeg provides the first land crossing over the West Channel of the Nelson River. This initial bridgehead links Ross Island to the mainland, and the control structure incorporates a roadway for two-way vehicular traffic. Extension of the Jenpeg access road to Cross Lake and to Norway House would connect these communities to the transportation corridor located to the northwest of the Outlet Lakes. The possibility of improved surface accessibility to these communities is being examined under the Canada-Manitoba Interim Subsidiary Agreement on the Manitoba Northlands which provides for highway preengineering and design studies for the purpose of locating and designing an extension of the existing Jenpeg road to Cross Lake and Norway House (Fig. 6-29).

The navigation routes on the Outlet Lakes are linked directly to marine transportation on Lake Winnipeg and to the Nelson River route below Cross Lake. Most marine freight is shipped from Selkirk. From Warren Landing at the natural outlet of Lake Winnipeg north to the Kiskittogisu Lake side of Whiskey Jack Portage the navigable depth is a minimum of 6 ft. Whiskey Jack Portage is the northern terminus of marine transport in the Lake Winnipeg-Outlet Lakes system. For vessels with greater draughts, such as the M.S. Lord Selkirk, Warren Landing is the northern most limit of navigation, and transshipment in years of low water levels to smaller vessels is required for freight destined further north. The length of the shipping season is approximately 165 days. At present the only navigational aids in the Outlet Lakes area are situated in the immediate vicinity of Warren Landing. Marine freight facilites are located at Warren Landing, Norway House, Whiskey Jack Portage and Cross Lake (Fig. 6-30).

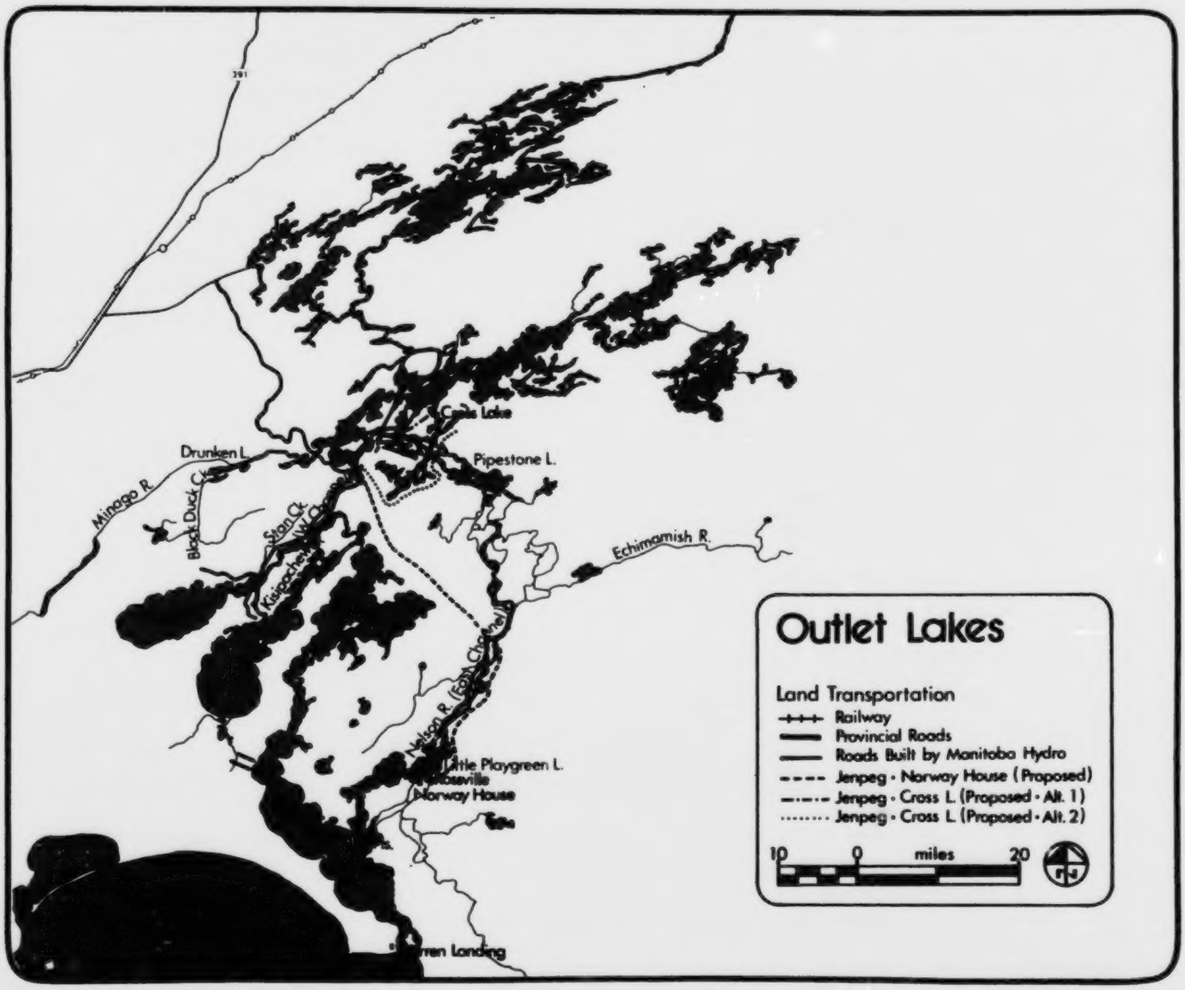

391
Cross Lake
Drunken L.
Pipestone L.
Minago R.
Black Duck Ck.
Stan Ck.
Kisipachew (W. Channel)
Echimamish R.
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
Warren Landing
Outlet Lakes
Land Transportation
Railway
Provincial Roads
Roads Built by Manitoba Hydro
Jenpeg - Norway House (Proposed)
Jenpeg - Cross L. (Proposed - Alt. 1)
Jenpeg - Cross L. (Proposed - Alt. 2)
10
0
miles
20

Fig. 6-29. Land Transportation and Proposed Road Network Extension, Outlet Lakes, 1973.

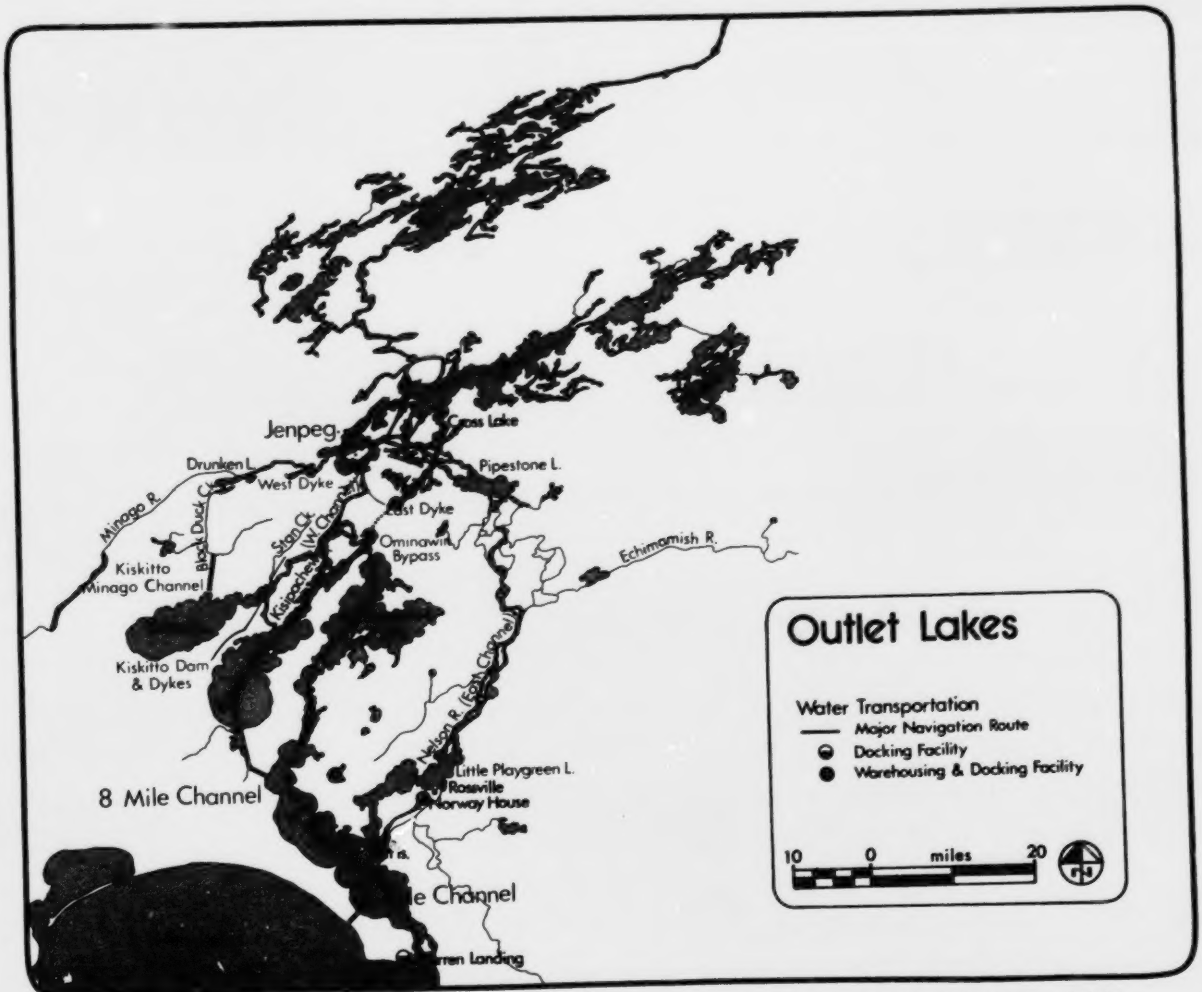

Jenpeg
Cross Lake
Drunken L.
West Dyke
Pipestone L.
Minago R.
Black Duck Ck.
Stan Ck.
(W. Channel)
East Dyke
Ominawin Bypass
Echimamish R.
Kiskitto Minago Channel
Kisipachewuk
Kiskitto Dam & Dykes
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
8 Mile Channel
le Channel
rren Landing
Outlet Lakes
Water Transportation
Major Navigation Route
Docking Facility
Warehousing & Docking Facility
10
0
miles
20

Fig. 6-30. Water Transportation Services and Facilities, Outlet Lakes, 1973.

Float equipped aircraft service is provided to Norway House and Cross Lake to supplement the wheeled aircraft service. There are two regular service airstrips at Norway House and Cross Lake and an emergency landing strip at Warren Landing. Manitoba Hydro has constructed airstrips to service the construction sites at Jenpeg and the 8-Mile Channel.

EFFECT ON TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES - The various structures under construction in the Outlet Lakes area associated with the regulation of Lake Winnipeg, will have a number of differing effects upon the transportation facilities and services.

All-weather roads in the area are all above the regulated mean water levels and will not be affected. As indicated, hydroelectric development resulted in construction of the Jenpeg access road from Provincial Road 373 which connects to Provincial Road 391. Existence of this road within 20 miles of Cross Lake community decreases the surface isolation of this community.

Truck transport over winter roads in the area supplies consumer goods to the communities at freight rates lower than by air supply. With construction of the Jenpeg access road, the length of the winter road to Cross Lake community has been shortened to 20 miles. The winter truck roads to Cross Lake and Norway House traverse open stretches of ice. The 60-mile road from Provincial Trunk Highway 6 to Norway House must cross a 10-mile stretch of ice on Playgreen Lake. With new levels and flows in the area, new ice patterns may form, requiring care in constructing the winter roads in future. The effect of the hydroelectric project on winter transportation is discussed in detail later in this section.

The Hudson Bay line of Canadian National Railways, whose route and roadbed are located to the northwest at the periphery of the Outlet Lakes area, will suffer no physical effect from changes in water level resulting from hydroelectric development. The Jenpeg access road could make Wabowden, the closest railhead, a possible transshipment point for inbound and outbound bulk cargo. Integration of transportation modes should develop in the future.

All three diversion channels, the 2-Mile Channel, the 8-Mile Channel and the Ominawin Bypass, are to be maintained at a minimum depth of 25 ft. These factors, coupled with the increase in present depth from 2 to 5 ft in the West Channel resulting from the forebay created by the Jenpeg structure, will make the passage of vessels of 6 to 8 ft draught possible as far as the Jenpeg site. A navigation lock at the Jenpeg structure would allow passage directly by boat from Selkirk or Winnipeg to the community of Cross lake.

Navigation in the Outlet Lakes may be hampered by floating debris and dead standing timber. Channels, narrows, and fully or partially inundated islands, will be the major hazards; timber clearing will reduce the potential risks. New channels created by hydroelectric development and their attendant hazards, may require marking with navigational aids. These channels may possibly alter the existing route, and it may become necessary to install aids to navigation to provide for safe passage of large vessels (Fig. 6-30).

At the outlet of Lake Winnipeg in the 5-mile approach to Warren Landing the lakebed profile ranges from 10 to 30 ft. With construction of the 2-Mile

Channel, large vessels may bypass Warren Landing and these dangerous, shallow waters. This could reduce the use of Warren Landing as a transfer point for freight.

At present, Warren Landing serves as a transshipment point for goods from the south destined for Norway House or Cross Lake. Any vessel with too great a draught, and unable to navigate farther, must transfer freight traffic to smaller boats during periods of low water levels. The deck elevation of the wharf is 718 ft and the structure will not undergo flooding as a result of the regulation of Lake Winnipeg.

Norway House serves as an air freight supply centre for isolated communities such as Oxford House, Garden Hill and Shamattawa. It receives goods by barge for reshipment by air to these settlements. There are two major marine freight handling facilities in Norway House, one on Fort Island, and one at Rossville on the mainland. The deck elevation of the Fort Island wharf is 717 ft and it should not be affected by regulation. The wharf at Rossville consists of two levels: the upper level is at an elevation of 717 ft while the lower level is at 714.3 ft. In times of high water under regulated conditions the lower section could be flooded while the upper section will not be affected.

Freight for Cross Lake community is portaged at Whiskey Jack Narrows to bypass the unnavigable stretches of the West Channel. Wharves, built by the Marine Branch, Canada Department of Public Works, are situated at each end of the portage between Kiskittogisu and Cross lakes. The deck elevations are such that flooding of both wharves will take place. The deck elevation of the Kiskittogisu Lake wharf is 713.5 ft and it could be flooded at times of high water after regulation. The deck level on the Cross Lake end is 685.0 ft, and is lower than the regulated maximum level of 685.9 ft; thus it may be subject to periodic flooding.

The main dock at the Cross Lake community is owned by the Hudson's Bay Company and is located on the east shore of the Nelson River. The dock will not be flooded as it is above the 685.9 ft elevation, the maximum regulated flood stage.

The floatplane base at Norway House will remain unaffected by the fluctuations caused by the Jenpeg control structure. However, the new flows and fluctuations will influence the Cross Lake base where, with greater flows, landings and takeoffs will require more care.

The airstrip at Cross Lake (elevation 690 ft) will remain well above future high water levels. However, there may be an indirect effect on the airstrip due to flooding of low portions of the access road which is below the 685.9 ft maximum elevation. Sections of the access road, totalling 3400 ft, may be flooded and would have to be raised to a higher elevation. Portions of the airstrip at Norway House are below elevation 718 ft and could be subject to flooding. The airstrips at Jenpeg (elevation 727 ft) and at the 8-Mile Channel built and operated by Manitoba Hydro will be above any future levels (Fig. 6-31). The airstrip at Jenpeg will remain as a permanent facility and will thus provide another wheeled aircraft link for the Outlet Lakes area (Fig. 6-32).

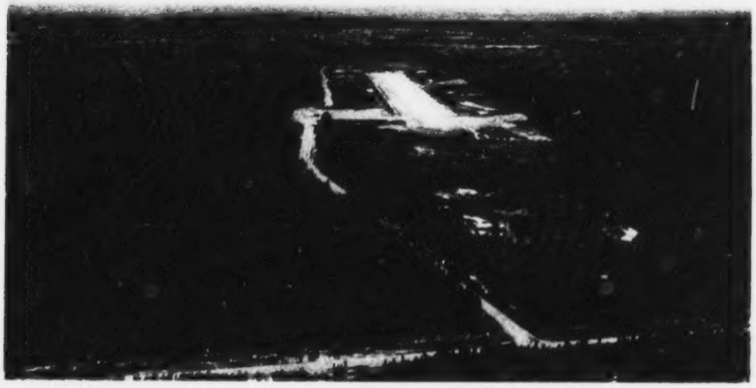


Fig. 6-31. Photograph of Jenpeg Access Road and Runway, 1972.

EFFECT ON TRANSPORTATION SERVICES TO NORWAY HOUSE AND CROSS LAKE COMMUNITIES - The main intra-regional personal travel pattern is between Norway House and Cross Lake. Three methods of travel are in use on this route: by small boat or canoe from Norway House to Whiskey Jack Landing, over the portage on foot or by truck to Cross Lake and by small boat to Cross Lake, or along the East Channel via Pipestone Lake to Cross Lake community by boat; by winter road; and by aircraft, either charter or regularly scheduled flights by Midwest Airlines.

The regulation project will have little foreseeable effect on either travel in winter or travel by air. Small boat travel may possibly be altered. The Jenpeg control structure will create a forebay which may be navigable by small craft. This, coupled with the Ominawin Bypass, will result in access to Cross

Lake via a short portage at the Jenpeg control structure, eliminating the portage at Whiskey Jack Narrows.

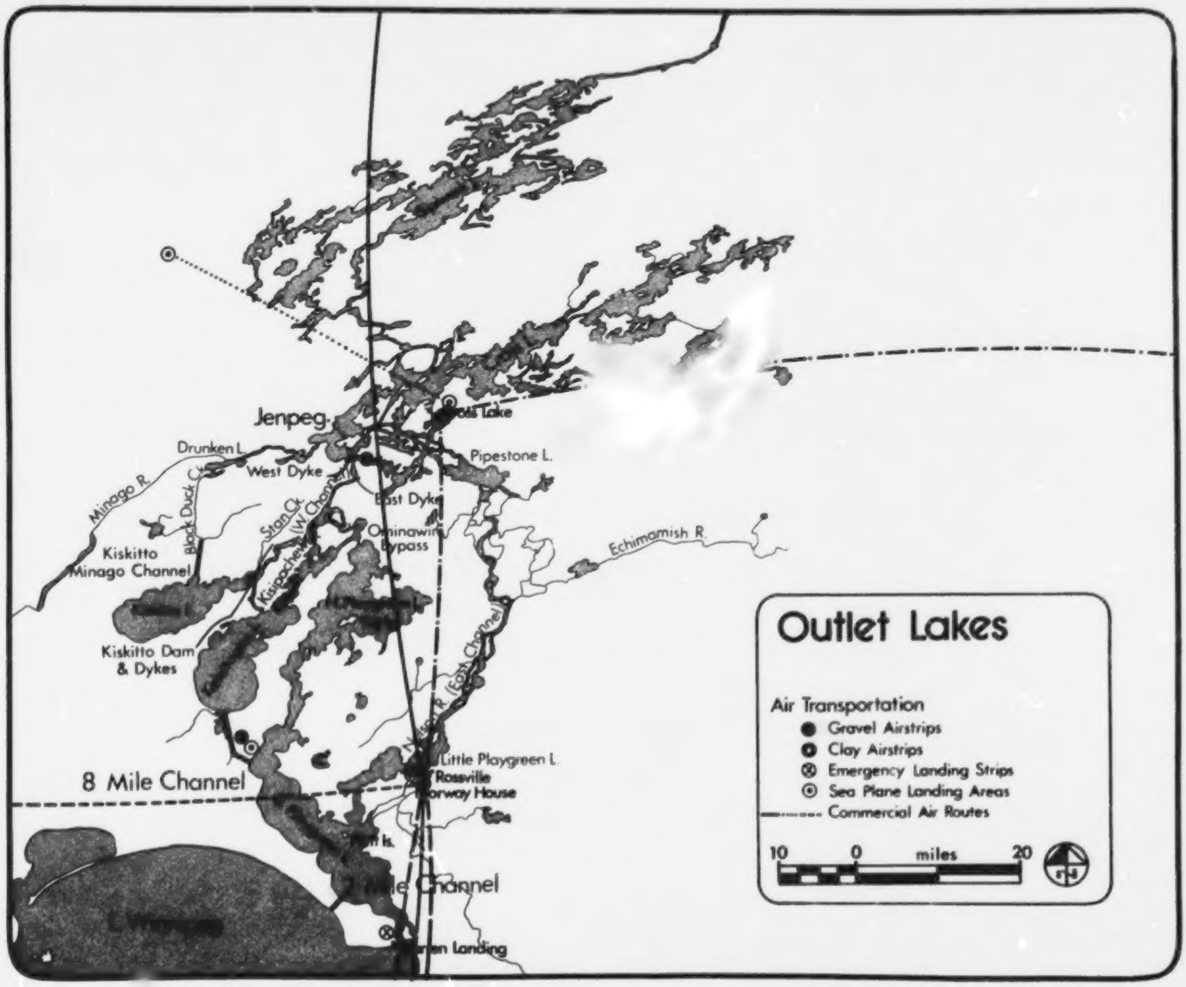

Outlet Lakes
Air Transportation
● Gravel Airstrips
● Clay Airstrips
⊗ Emergency Landing Strips
⊙ Sea Plane Landing Areas
Commercial Air Routes
10
0
miles
20
Jenpeg
oss Lake
Drunken L.
West Dyke
Pipestone L.
Minago R.
Black Duck Cr.
Stan Cr.
Kisipachewuk (W. Channel)
East Dyke
Ominawin Bypass
Echimamish R.
Kiskitto Minago Channel
Kiskitto Dam & Dykes
Nelson R. (East Channel)
Little Playgreen L.
Rossville
orway House
8 Mile Channel
Mile Channel
en Landing

Fig. 6-32. Air Transportation Services and Facilities, Outlet Lakes, 1973.

With respect to inter-regional personal travel between the Outlet Lakes and the rest of the province, due to present lack of land access, the primary mode is the airplane. Both Norway House and Cross Lake are serviced by scheduled flights from Winnipeg; and Cross Lake has air access to Wabowden. Charter service is available to both Norway House and Cross Lake by various airlines. At present, road travel is restricted to the Jenpeg access road connection with Provincial Road 373 and subsequently Provincial Road 391. Automobile travel from

Norway House would require extension of the Jenpeg road to the community. Access to Cross Lake from the outside could be provided by a direct road link with Jenpeg, an air shuttle service, or a ferry service between Cross Lake and Jenpeg.

Inbound freight for Norway House (perishable foodstuffs, non-perishable general cargo and fuel oil) is shipped by boat or barge from Winnipeg or Selkirk during the navigation season. In winter most supplies are transported by Provincial Trunk Highway 6 and winter road. Air freight is used mainly during freezeup and breakup and is also used extensively for shipment of perishable foodstuffs.

Transportation of cargo into Norway House could be altered considerably as a result of the regulation project. Extension of the Jenpeg road to Norway House would connect the community to the provincial road network making year-round shipment by truck possible. The high cost of transportation may encourage the development of a truck link from Norway House to Wabowden to connect with the railway from Wabowden to The Pas and Winnipeg.

Summer freight to Cross Lake is delivered by boat and barge from Winnipeg through Warren Landing to the south end of Whiskey Jack Portage. The freight is trucked across the portage and transshipped by barge to Cross Lake. Winter freight in the past has gone by truck or rail to Wabowden, then by tractor train to Cross Lake. Air freight is shipped either by direct service from Norway House and Winnipeg or in summer by floatplane from Wabowden.

Construction of the Jenpeg road has put Cross Lake within 20 miles of an all-weather road. The winter road, formerly from Wabowden, now begins at Jenpeg, a reduction in distance of 35 miles. There is a possibility that some of the inbound movement of freight now being barged in summer to Whiskey Jack Portage could be transported by truck to the point where the Jenpeg access road crosses the Minago River. Currently, a few culverts form the crossing. However, the Manitoba Department of Highways is planning to replace these with a bridge and connecting causeway. From the Minago River crossing, freight could be transshipped by boat or barge to Cross lake. The situation would be altered with extension of the Jenpeg access road to Cross Lake. An all-weather road connection would eliminate the disadvantages of transshipment. With improvements to the navigation route resulting from the diversion channels and the Jenpeg forebay, bulk cargo might be shipped to Cross Lake from Winnipeg by barge either by means of transshipment at the Jenpeg structure or direct by way of a lock structure if installed in the Jenpeg dam (this was a possibility not examined by the Study Board).

EFFECT ON WINTER TRANSPORTATION - The Lake Winnipeg regulation project will have varying effects on the present winter transportation routes. However, actual effects on specific areas and consequent remedial measures can only be speculated on until conditions during the first year of operation have been observed and analysed. This applies particularly to the Cross Lake area where there is lack of pertinent data. As a result, a monitoring program has been established by Manitoba Hydro to obtain the required data. In addition to the monitoring program for Cross Lake, performance of the 2-Mile and 8-Mile channels will be closely monitored by Manitoba Hydro during the first few winters of regulation.

The Civil Department, Generation Projects Division, Manitoba Hydro, has prepared two interim reports on winter transportation in the Outlet Lakes area (August 1973 and 1974). The 1973 report indentified three winter routes (predominantly snowmobile and tractor train routes) that may be affected by regulation. Wabowden-Cross Lake route, crossing several ice covered channels enroute from the west side of Cross Lake to Cross Island; portage route at Whiskey Jack Landing, crossing that portion of Cross Lake fed by waters of the East Channel; and Norway House-Cross Lake route, also crossing that portion of Cross Lake fed by the East Channel.

Winter ice conditions are important to transportation since they play a large part in determining the volume of winter freight entering the communities.

As a result of regulation, winter levels on Lake Winnipeg and the Outlet Lakes will generally be higher, and winter flows will be substantially increased. There will be a period of about 2 weeks duration during the latter part of November (the initial ice formation period) when the total outflow from Lake Winnipeg will be reduced at Jenpeg to an average flow of 50,000 cfs. This is referred to as the "cutback" period. The "cutback" period is designed to allow a stable ice cover to form in the Ominawin Bypass, the 8-Mile Channel and the 2-Mile Channel. Day to day fluctuations of up to 15,000 cfs will be considered. If problems occur with the forebay ice cover as a result of fluctuations of this magnitude, reductions in allowable fluctuations will have to be made. Calculations indicate that daily flow variations of as much as 15,000 cfs would cause negligible daily fluctuations on Cross Lake.

As a result of the November "cutback" period, there will be level fluctuations throughout the system. In some areas upstream of Jenpeg the increase in flow after the "cutback" period will result in longitudinal cracks forming along each side of the channel. Downstream of Jenpeg this "cutback" release and associated increase in water level will result in some flooding of the Cross Lake ice cover.

Effect on the 2-Mile Channel - It is anticipated that east-west traffic wishing to cross this channel will not be extensive. Ice cover on the channel will be extremely rough and irregular. To cross the channel, an ice bridge will have to be maintained over reaches which may have velocities of up to 3 ft per second (fps). There will be an open water area of variable length at the upstream end of the channel.

Traffic between Warren Landing and Norway House crosses the Nelson River just downstream of Purvis Island and then proceeds to Norway House along the north shore of Playgreen Lake. In some years ice conditions at this crossing will not permit use of the route. Traffic may then follow the south shore of Playgreen Lake up to the crossing of the winter road from Provincial Trunk Highway 6 to Norway House.

Effect on the 8-Mile Channel - It is not expected that north-south traffic on the winter road between Provincial Trunk Highway 6 and the 8-Mile Channel area will be significant. Traffic wishing to cross the channel would have three possibilities: cross upstream of the channel entrance, out in Playgreen Lake; cross over an ice bridge in the upper 5000 ft of the channel where velocities range from 1.0 to 1.5 fps throughout the winter; and, as the least desirable alternative, cross over an ice bridge in the lower reaches of the channel on an extremely rough and irregular ice cover. With higher velocities of up to 3 fps, an ice bridge could not be maintained in this area as long as in the upper reaches.

Effect in the Norway House Area - A section near the crossing of the winter route from Norway House to Cross Lake was analysed in 1973. It was calculated that velocity would increase with regulation by less than 0.10 fps which would have little or no effect on ice formation or stability. However, there may be more significant increases in neighbouring areas with deeper and narrower cross-sections.

Effect in the Cross Lake Area - Traffic in the settlement area is composed of pedestrian, snowmobile and truck traffic. Truck and snowmobile crossing starts in late December or early January. Pedestrian traffic begins about 2 weeks after freezeup. Ice conditions on the snowmobile and truck crossing will require monitoring during the first years of regulation since the ice cover in the area may be weakened due to increased flows. Problems are sometimes encountered in the area immediately across from the band council office. These problems may become more severe after regulation and the re-routing of vehicle traffic, to cross farther south and follow the shoreline, may be necessary.

Cross Lake residents are concerned that currents will be stronger and thus the ice may not be safe in certain areas. A second major concern is that there will be slush on the ice due to water level fluctuations and increased discharges. This may be a problem for pedestrian traffic just after the November "cutback" period when a stable ice cover will have formed at a low stage; the rapidly increased discharges and subsequent stage may cause some local flooding of the ice cover already formed. This flooding should be restricted to the shoreline and will probably drain and freeze before the season of vehicle traffic. After the "cutback" period, there should be only minor fluctuations during the remainder of the winter. There probably will be few if any problems for vehicle traffic later in the winter. However, if fluctuations occur during the freighting period they will be of major concern. Fluctuations in the period prior to spring breakup may shorten the length of the season.

# EFFECT OF THE REGULATION OF FLOWS FROM LAKE WINNIPEG ON COMMUNITIES

There are three permanent communities in the Outlet Lakes area: Cross Lake (Fig. 6-33), Norway House-Rossville (Fig. 6-34), and Warren Landing (Fig. 6-35). The effects of the construction and operation of the works to regulate discharges from Lake Winnipeg on the communities of Cross Lake and Norway House were evaluated by the Planning Branch, Manitoba Department of Mines, Resources and Environmental Management. Warren Landing was not examined. The effects of the hydroelectric development on the economy, the labour force, community infrastructure and the social system of Cross Lake were identified and evaluated. In Norway House, the effects on the economy, labour force and community infrastructure are expected to be minor. Accordingly, the social impacts on the community were anticipated to be negligible and were not evaluated.

Fig. 6-33. Photograph of aerial view of a portion of Cross Lake Community, 1972.

## CROSS LAKE

The community of Cross Lake is dispursed along the southeast corner of Cross Lake for a distance of approximately 5 miles (Fig. 6-36). It is 40 miles from the nearest town, Wabowden, and 77 miles south of the closest large centre, Thompson. Its population is approximately 2000 permanent residents of which 1700 are Registered

Fig. 6-34. Photograph of aerial view of a portion of Norway House Community, 1972.

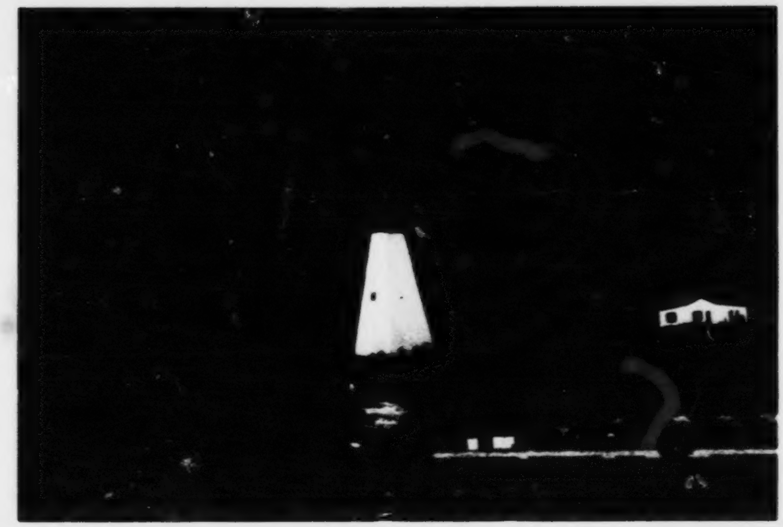
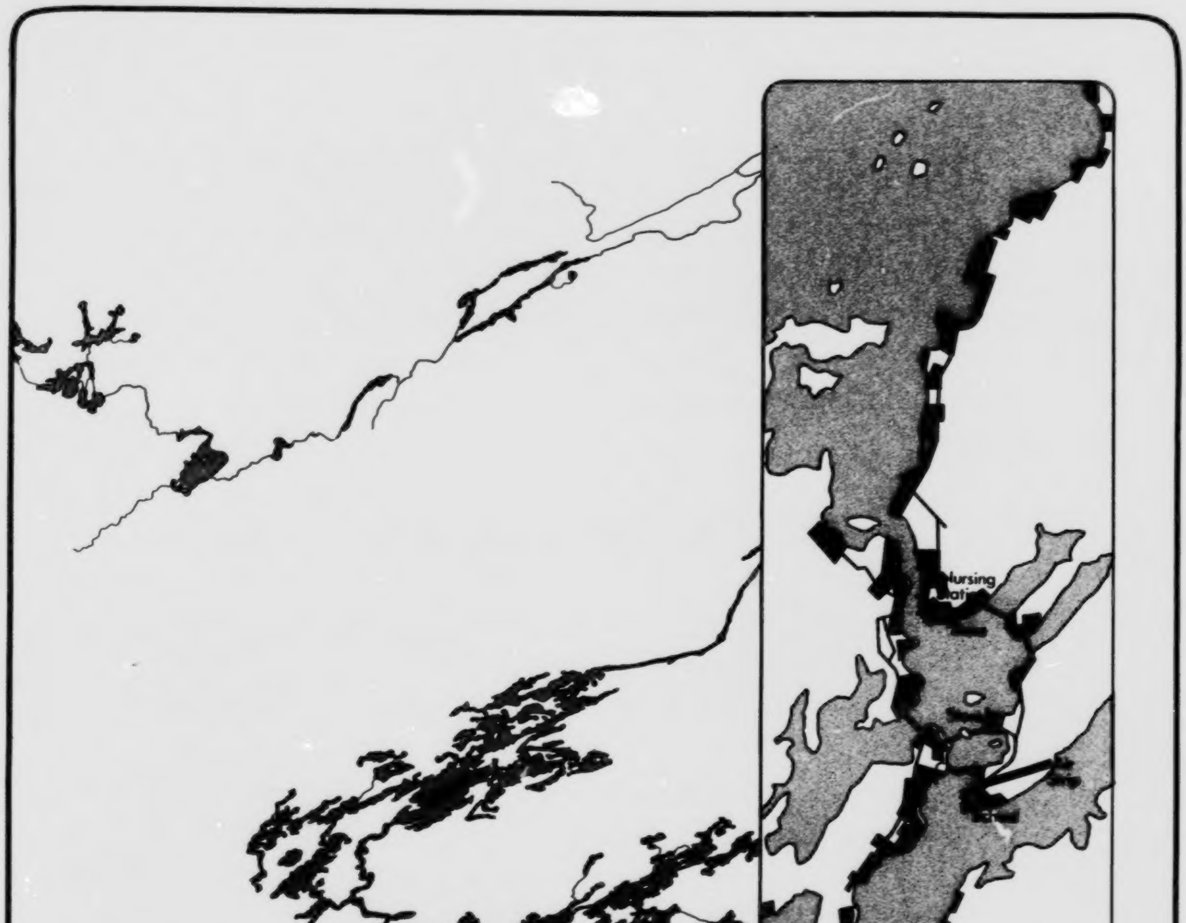


Fig. 6-35. Photograph of aerial view of a portion of Warren Landing, 1974.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Drunken L.
Pipestone L.
Minago R.
Black Duck Cr.
Stan Cr.
(W. Channel)
Kisipachew
Echimamish R.
INSET
Nelson R. (East Channel)
Little Playgreen L.
Rossville
Norway House
rren Landing
Outlet Lakes
Settlement
10
0
miles
20

Fig. 6-36. Cross Lake Community, 1971.

Indians and 230 are Non-Registered Indians. The existence of these two groups has resulted in a dual local government. The Registered Indians are governed by a chief and council, while the Non-Registered Indians are governed by a mayor and council. The chief and council are financially supported by the Canada Department of Indian Affairs and Northern Development while the mayor and council receive assistance from the Manitoba Department of Northern Affairs.

THE ECONOMY - In 1972-73, the community income of Cross Lake was $2,194,000 and the average income per person in the labour force, excluding income to transient residents such as teachers and nurses was $3,942. Fishing provided $175,000 (8 percent) of community income; trapping $42,000 (2 percent), hunting $100,000 (5 percent), forestry $16,000 (1 percent), construction $634,000 (29 percent), and service industries provided $164,000 (7 percent). The remaining $1,063,000 (48 percent) of community income was generated through government activities.

Three percent of community income was received in the form of cash and 12 percent in the form of income in kind (Fig. 6-37). Fifty-five percent was in the form of wage and salaries and 30 percent was in the form of government transfer payments.

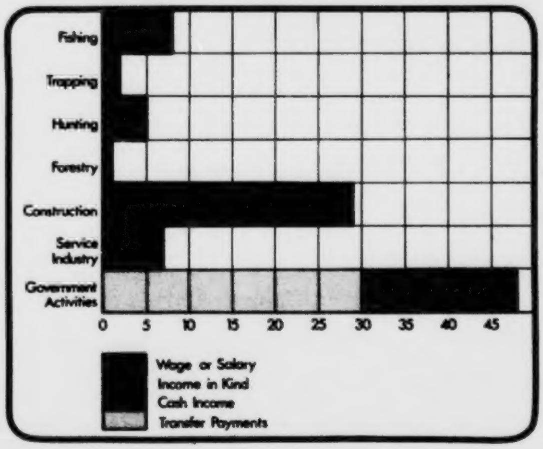


Fig. 6-37.
Estimated Percentage of Community Income by Activity and Type of Income for Cross Lake, 1972-73.

## EFFECT ON THE ECONOMY

Effect on Fisheries - In 1973, the commercial fishery provided approximately $43,900 in net income to the twenty-one fishermen of Cross Lake. In addition, the fishery provided the equivalent to $131,000 in the form of income in kind to the community. Employment and income in the traditional sector of the economy is expected to increase in the future because of the establishment of the Cross Lake Fishermen's Co-op Ltd. in late 1973. A slight short-term overall decline in the biological productivity of Playgreen Lake may result in a decline in harvests in the first 5 years of the regulation of discharges from Lake Winnipeg. However, after approximately 15 years of operation, potential harvests of the present commercial species are expected to slightly exceed present yields. The effect on the actual harvest is difficult to predict but it is probable that the decrease in biological productivity combined with possible changes in fish migration patterns are likely to result in short-term harvest decreases. In addition, access to fishing grounds and altered transportation facilities and services will probably have significant effects. Lower summer water levels on Cross Lake will make navigation on the lake more difficult, and may disrupt access to Walker Lake. Measures should be taken to ensure access to Walker Lake and safe navigation on Cross Lake through control of discharges from Lake Winnipeg. The winter fishery may also be disrupted due to weak ice conditions which may occur with regulation. Ice conditions should be monitored and safe transportation routes identified in order to prevent accidents. In addition, losses and damage to fishing equipment may occur because of the increase of floating debris resulting from regulation. The economic loss to the fishery and to community income has not been calculated.

The Jenpeg access road may reduce operating costs of the commercial fishery. At present, the commercial harvest is flown from Cross Lake to Wabowden where it is transferred to rail cars on refrigerated trucks for shipment to Winnipeg. The cost of air freighting has been estimated to be approximately 5.7¢ per pound from Cross Lake to Wabowden and 6.3¢ per pound from Walker Lake to Wabowden. If a holding station was installed at the mouth of the Minago River and a scheduled truck route and pickup established, transportation costs to Wabowden could be reduced by 50 percent. Assuming that these savings would accrue directly to the local fishermen, an average increase of $300 to $400 in annual net income per fisherman could be expected.

Effect on Trapping - From 1967-68 to 1972-73, the average annual number of persons trapping was 151. The average net annual income to trappers was $18,600 (Fig.6-38) with an additional $23,000 generated annually in the form of income in kind. The net annual income to the trappers is about 40 percent of the gross value of fur

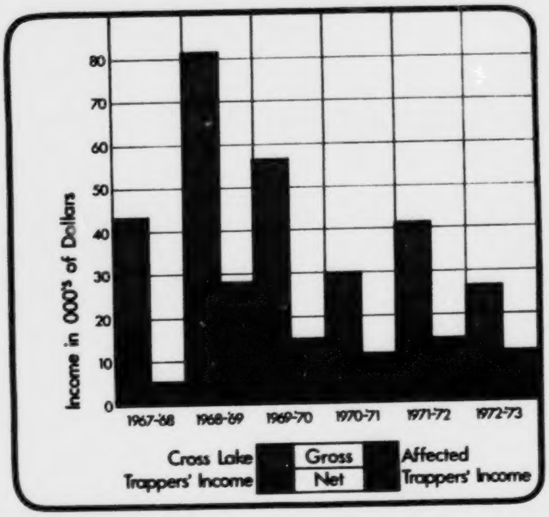


Fig. 6-38.
Gross Value and Net Income of Fur Harvested Over the Period 1967-68 to 1972-73 by Cross Lake Trappers.

harvested. The remaining 60 percent of total value is composed of royalty charges, auction fees, shipping, handling and marketing costs and trapper production costs.

There are twenty-five Cross Lake registered traplines located in the area that will be affected. Over the period 1967-68 to 1972-73, an average of eighty trappers were employed in trapping. Over this same period average net income to trappers totaled $5,701 and average gross value totaled $14,252 (Fig. 6-38). This represents approximately one-third of the total value of fur harvested from the Cross Lake traplines. The trapline which is for community use will be flooded. There are intangible values to this line in addition to the return from fur. It is used as a training ground for young trappers and as an area where older residents can continue to trap as a recreational activity. It also provides local residents with a large proportion of their food.

The projected annual losses in biological production by species, based on the average price of pelts over the period 1967-68 to 1972-73, are equivalent to $1,045 of beaver production; $6,044 of muskrat; and $289 of mink production. In addition to the loss in biological productivity, the productivity of the trappers may be affected. Access to traplines may be difficult due to weak ice conditions and new trails along trapping blocks will have to be cut. The loss in furbearer productivity combined with losses in trapper productivity are anticipated to result in an annual loss in harvest equivalent to $9,280 in gross value and $3,720 in net community income (based on average fur prices over the period 1967-68 to 1972-73).

The loss in food derived from these traplines has been estimated to be equivalent to an annual loss of $4,600 in community income.

Trappers should be compensated for losses of traps and cabins either by a cash payment or by replacement. Trappers should also be compensated for losses of income and of income in kind.

Effect on Hunting - A substantial amount of the food supply of the Cross Lake residents is obtained from hunting moose and waterfowl. It has been estimated that hunting provides the equivalent of 5 percent of total community income. With the regulation of discharges from Lake Winnipeg, moose habitat will be lost and subsequent reduction in moose populations is anticipated. It is expected that moose harvests may decrease because of the reduction in populations. Reduction of waterfowl habitat is expected in some areas. However, the effect on harvests is not known. The greatest effect has been a short-term decrease in moose and waterfowl populations because of an increase in hunting pressures caused by the influx of construction workers to the area.

Effect on Local Forestry Activities - The forestry industry employed approximately eight people from Cross Lake in 1972-73 and generated a total gross income of $16,000 within the community. There appears to be a potential for a small modern operation to serve the local market. It would seem desirable to replace the facility presently in use. The hydroelectric development is not expected to have any effects on this sector of the Cross Lake economy.

Effect on Construction Activities - Income derived from construction work accounted for 29 percent of community income in 1972-73. The entire amount was generated by the construction of the Lake Winnipeg regulation project including the Jenpeg generating station. Approximately 100 people were employed in 1972-73 and about $634,000 of income was generated in the community. This constituted approximately 52 percent of total community income earned in the form of wages and salaries in 1972-73. In addition to generating employment and income the hydroelectric project enabled a small number of people to receive some training.

Future employment opportunities are difficult to predict; however, jobs in the construction sector will probably decrease rapidly as the hydroelectric development at Jenpeg nears completion. A low in employment will be reached in 1976. After that time, approximately six permanent skilled positions and a few semi-skilled seasonal jobs on a reservoir management program will be available at Jenpeg.

THE LABOUR FORCE - Of the estimated population of 2000, 1060 people are under the age of sixteen, and only seventy-nine are over sixty-five years of age (Fig. 6-39). Approximately 870 are between the ages of sixteen and sixty-five years. The labour force, which was defined as all persons between the age of sixteen and sixty-five who were not attending school full time and who were not married women, unwed mothers or separated women with children, was estimated to be 548. Four hundred and fifty-one were males and ninety-seven were females. The majority of the labour force was male between the ages of twenty and forty (Fig. 6-40).

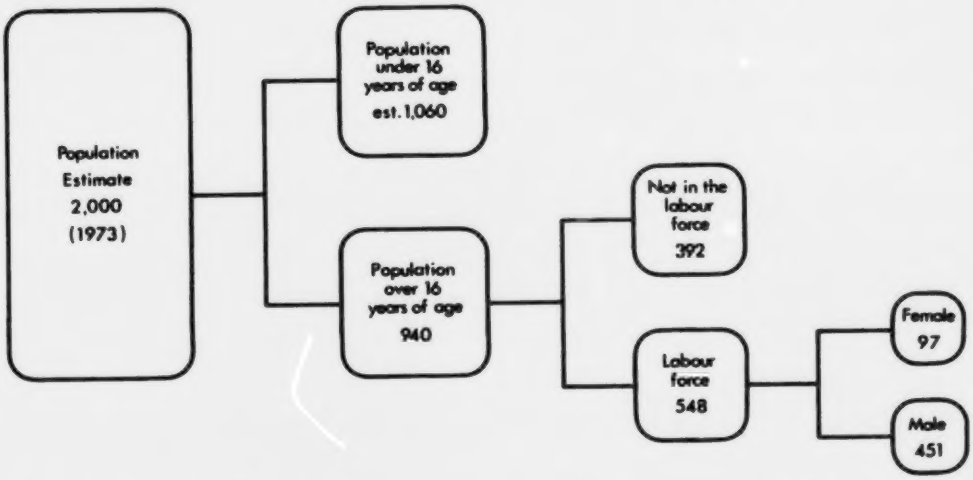

Population Estimate 2,000 (1973)
Population under 16 years of age est. 1,060
Population over 16 years of age 940
Not in the labour force 392
Labour force 548
Female 97
Male 451

Fig. 6-39. Cross Lake Population and Labour Force Distribution, 1973.

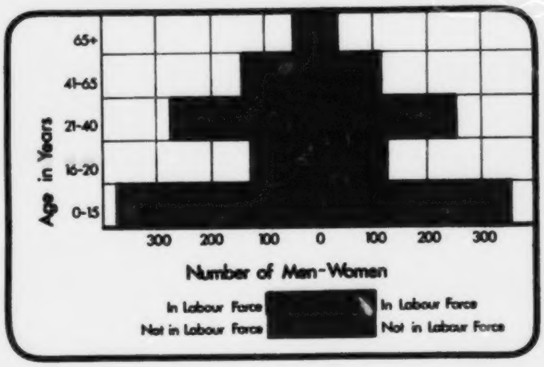


Fig. 6-40.
Age-sex Distribution of the Cross Lake Population and Labour Force, 1973

Approximately 5 percent are qualified tradesmen, professionals or persons with management experience. Semi-skilled persons, mostly in construction trades, account for a further 22 percent, while 55 percent are classified as unskilled. In addition, 18 percent have been classified as fishermen or trappers with no other occupation.

Education levels are lower than the provincial average. Those under thirty years of age and no longer attending school have an average level of formal education of grade seven or eight. Persons between thirty and forty-five are at approximately grade six level, while those over forty have even lower standards of formal education. It should be noted that within the context of the local economy and the perceived needs of this community, the validity of this type of education can be questioned. In addition, high school upgrading courses and vocational training courses are offered on an ongoing basis by both federal and provincial agencies.

The mobility of this labour force is difficult to determine. One factor which impedes the incentive to leave the community to take either temporary or permanent employment elsewhere is language. Approximately twenty-five members of the labour force over forty years old do not speak English. Further constraints to mobility exist in the strong family ties prevalent in Cross Lake, as well as the acknowledged constraints of inadequate education and skills relative to provincial standards. In addition, the lack of transportation facilities in and out of the community impedes mobility, particularly in the case of temporary and commuting types of employment. There is no all-weather road link to Cross Lake and, hence it becomes more costly and less convenient for residents to leave the community to find employment.

Attitudes to work in general, and to leaving the community to find employment in particular, were analysed through an examination of the past work history of the community and through a series of interviews with local residents. Examination of historic employment data for this community indicates that there is quite a strong tendency to enter the wage economy and to leave the community temporarily to find employment. Interviews with people in the labour force indicate that there is an awareness that jobs are scarce in Cross Lake and that more opportunities exist outside the community. Approximately 60 percent of respondents indicated that they would be willing to move to better employment. The reasons for moving centred around expectations for permanent employment and for a wider variety of future opportunities for their children.

EFFECT ON THE LABOUR FORCE - The Lake Winnipeg regulation project is making available large numbers of short-term construction jobs to northern residents. It is estimated that 800 jobs will be available on the lake Winnipeg regulation project in 1975, 300 in 1976, and 200 in 1977. Most of these jobs require skilled workers; however, approximately 150 labourers will be required in 1975 (Table 6-8).

TABLE 6-8
PROJECTED JOB VACANCIES BY OCCUPATIONAL GROUPING FOR THE LAKE WINNIPEG REGULATION PROJECT, 1975

| Occupational Group | 1975 |
|---|---|
| Labourers | 145 |
| Operating Engineers | 120 |
| Teamsters | 80 |
| Carpenters | 145 |
| Rebar Workers | 40 |
| Iron Workers | 25 |
| Electricians | 30 |
| Pipefitters and Mechanical Workers | 40 |
| Caterers | 80 |
| Inspection and Supervision | 95 |
| TOTAL | 800 |

Up to March, 1974, actual employment on the project averaged 375 local residents[6-3] monthly. Indications are that employment of local residents has increased above this level; however, documentation is not yet available. Many of these jobs require at least some previous training or skill, facility in the English language, and a willingness to move to the jobs. This willingness to move can be constrained by strong family ties, the difficult adjustment required in moving from the familiar social and cultural milieu of home, and the lack of all-weather road access between home and job site. All of these factors are expected to reduce participation by Cross Lake residents in the general wage economy and specifically in the labour market for hydroelectric development.

The Lake Winnipeg regulation project has provided some training for a large portion of the local labour force. While the majority have been employed as labourers, some have received basic training in carpentry, equipment operation, and cooking.

GOVERNMENT TRANSFER PAYMENTS - Cross Lake received approximately $668,000 in government transfer payments during the period April, 1972, to March, 1973. These payments were in the form of social assistance, family allowance and old age pensions. Little use was made of unemployment insurance benefits. Social assistance accounted for $466,400 (70 percent) of total payments, while family allowance and old age pensions accounted for $96,000 (14 percent) and $104,000 (16 percent), respectively.

EFFECT ON GOVERNMENT TRANSFER PAYMENTS - Transfer payments are anticipated to increase as employment on the Lake Winnipeg regulation project decreases and as more people enter the labour force and are unable to attain employment. The labour force is expected to increase by approximately 250 to 300 persons in the next 5 years. Ironically, the resource base of the area does not appear to be capable of providing substantially greater levels of employment than exist at present. There will be some future employment opportunities in forestry operations in the Sipiwesk Lake area and in tourism throughout the area. Within the community, job opportunities in the service sector are anticipated to expand, but not substantially. Therefore, unemployment is expected to be very high in the future and out-migration from Cross Lake will probably occur as jobs in the vicinity of Cross Lake become increasingly scarce.

COMMUNITY INFRASTRUCTURE - There are six schools in the community, a nursing station, local government offices, a post office, one large store (Hudson's Bay Company), and a number of churches. Recreational facilities include two buildings which can be used as theatres, two outdoor hockey rinks, sport fields, a beach and a pool hall. There is also a small restaurant and general store. Police services are provided by two band constables, one community constable and by the Royal Canadian Mounted Police. There is no centralized water supply or sewage system. The community now has telephone and television service as well as diesel electric power service.

Internal transportation facilities include gravel and dirt roads along the east and west shores at the community. Four causeways provide links in the road system. However, there is no permanent road across the Nelson River linking the east and west portions of the community. During open water, this linkage is provided by a footbridge while, in winter, the ice is utilized. There is no commerical taxi or bus service available in the community. However, transportation of school children is provided by boat during open water and by snowmobile during winter. The Nelson River is used as a main internal transportation system by boat in the summer and snowmobile in the winter. Residents tend to live near the shore to take advantage of this natural transportation facility.

External transportation services are provided at present by air, water and winter road. An airstrip is maintained and operated by the Manitoba Department of Northern Affairs. Water transportation, via the portage of Whiskey Jack Narrows is provided during open water by M. & S. Freighting. The volume of freight shipped into the community via this route has declined over the past few years. Road transportation into the community is confined to a winter road constructed annually. In recent years, the route of this road was from the mouth of the Minago River (near the Jenpeg construction camp) across the ice on Cross Lake to the community.

There are three major water intake structures which supply water to the community. At least one of these structures does not work reliably. Chlorination of water takes place regularly only at the nursing station.

Most of the population depends upon surface water for domestic purposes although some shallow wells exist on the mainland. The chemical quality of water from the Nelson River generally meets most of the requirements of the "Canadian Drinking Water Standards, 1968". However, the water does not meet the standards for the physical parameters of turbidity and colour. In addition, the water is unsafe for human consumption without prior treatment due to the high bacterial count. The Lake Winnipeg regulation project is expected to increase the suspended solids. However, the proportion of suspended solids is already very high and the increase will be relatively insignificant.

Residents are primarily dependent upon privies for sewage disposal. The old school site is serviced by a septic tank which discharges into the lake. The new school complex is served by an extended aeration plant. It is anticipated that the effects of regulated discharges from Lake Winnipeg on the dilution of sewage will be minimal.

EFFECT ON COMMUNITY INFRASTURCTURE - There are twenty-five structures, including four houses located at or below the regulated maximum water level (686.5 ft). Wind set-up and ice conditions could result in damage to another twenty structures located below elevation 690 ft. There are four causeways and four footbridges that are located below elevation 686.5 ft. However, these facilities have been subject to flooding in the past and the Manitoba Department of Northern Affairs has undertaken a construction program to upgrade these structures.

All docks, homes and structures affected by higher water levels with regulation should be relocated or replaced after consultations with the owners of the property.

There is also a possibility of weak ice conditions in the vicinity of the community. This could create a safety hazard for the residents because the lake is heavily utilized for internal winter transportation. A monitoring program should be established to identify and mark safe crossing areas on the lake.

External transportation disruptions could be more significant. Higher summer water levels on Kiskittogisu Lake may result in the periodic flooding of facilities at Whiskey Jack Landing. There is also a slight possibility that the wharf at the Cross Lake end of the Whiskey Jack Portage will be flooded. Undetermined changes in ice conditions on Cross Lake could be the most critical factor in disrupting external transportation to Cross Lake. Poor ice conditions after regulation could result in a serious disruption of freighting operations on the winter road. This would depress the general level of community services and the cost of living, since most freight enters Cross Lake across the ice. Tentative plans developed by the Manitoba Department of Northern Affairs indicate that Cross Lake will probably become the supply centre for communities located in the northeastern part of the province, including Oxford House, Gods Lake and Island Lake. Future disruptions of freighting to Cross Lake could therefore have repercussions on these communities. Established movement patterns for trappers could also be disrupted by poor ice conditions.

SOCIAL SYSTEM - The community of Cross Lake has a relatively good general understanding of the changes that will result from Lake Winnipeg regulation and the effects this will have on their economy and the infrastructure. They have received information from a variety of sources including local newsletters, radio broadcasts, meetings with government agencies, Manitoba Hydro representatives, and through a co-ordinating committee established in 1971.

There appears to be a fairly distinct difference between the outlook of the older people (over forty to forty-five years) and those of the younger people. The younger people have a relatively modern world view for a remote community. Attached to this modern view are new emerging values, particularly in relation to earning a living. Whereas many of the older people are still tied to the traditional activities of hunting, trapping and fishing, the vast majority of the young place a greater value on entering the wage sector of the economy. This emphasis is changing attitudes towards the family and the community, and the general acceptance of greater mobility is decreasing family and community ties. The hydroelectric development has acted as a catalyst in changing these attitudes.

The most distinctive feature of the Cross Lake leadership is its duality. Leadership lies largely within the two elected councils, the community council and the band council, and a few other influential individuals. However, there are many other leaders on the periphery of this leadership core.

In the case of the Registered Indian people, who comprise 88.5 percent of the population, the band council has the responsibility for administering (financially and managerially) all ongoing programs relating to their people. The band council is perceived as being highly institutionalized, in both the minds of the leaders themselves and the residents of the community.

In the case of the non-Registered Indian people, leadership is more diverse with only one-half of the leaders being members of the community council. This council represents 11.5 percent of the population and its current responsibilities are limited to lobbying for various government programs for their constituents.

Generally, these councils deal with any issue by using the government agency with which they are most familiar. There is an increasing need for community participation in planning and action rather than the traditional council approach. However, it will be difficult for the community to pursue a co-ordinated approach if the government agencies with which it deals do not adopt a similar approach.

The changes accompanying the hydroelectric development will affect the structure and membership of both councils. The need for community planning for these changes provides the opportunity for both the community and associated government agencies to co-ordinate their approach to community problem solving.

The majority of decisions about local community affairs are made independently by either the band council or the community council. Many of the decisions made by the band council are more substantive than those of the community council because of the broader authority and responsibility held by the band.

The two councils use the same decision-making technique, that of direct decisions by the council without the input of public opinion or referendum. This system of decision-making has the advantage of speed while possessing the inherent danger of lack of commitment or support from the general populace.

The need to solve the many and varied problems associated with rapid change has put unprecedented pressures on community decision-makers, who must now deal with a large number of more complex issues in a shorter time than ever before. The community of Cross Lake has a modern form of decision-making which allows it to make many decisions, and quickly. Thus, it is equipped to handle the new pressures caused by the hydroelectric development. However, with the increasing complexity of the decisions required, it is becoming more difficult for the core of leaders to acquire adequate background information upon which to base decisions. Furthermore, most decisions are made independently by each council, despite the urgent need for co-ordination. Therefore, as change continues, there will be an increasing need for joint planning between the two councils or for the establishment of advisory committees to co-ordinate the decisions in the community.

EFFECT ON THE SOCIAL SYSTEM - The social system of the Cross Lake community has undergone substantial changes in recent years, and the effect of the regulation project is acceleration of the rate at which these changes are taking place. The value of community and family ties has been decreasing while the value of entering the wage sector of economy has been increasing. The rate of this change in values is being accelerated as a result of the regulation project. Studies indicate that the people of Cross Lake are receptive to change and, therefore, the increase in the rate of change has caused relatively little stress to the people.

Knowledge of the regulation project and the changes that it will cause is relatively widespread in the community. In addition, community political structures and decision-making processes are efficient and able to resolve the issues arising from the hydroelectric projects. However, issues are becoming more complex and co-operation between the two community councils to exchange information and conduct joint planning is necessary.

## NORWAY HOUSE

The community of Norway House is located on the East Channel of the Nelson River approximately 18 miles north of the outlet of Lake Winnipeg (Fig. 6-41). The population is approximately 3000 of which approximately 67 percent are

Registered Cree Indians. The remainder are non-Registered Indians and a small group of transient professional people mainly in the medical and educational fields. Approximately 47 percent of the population is under fifteen years of age.

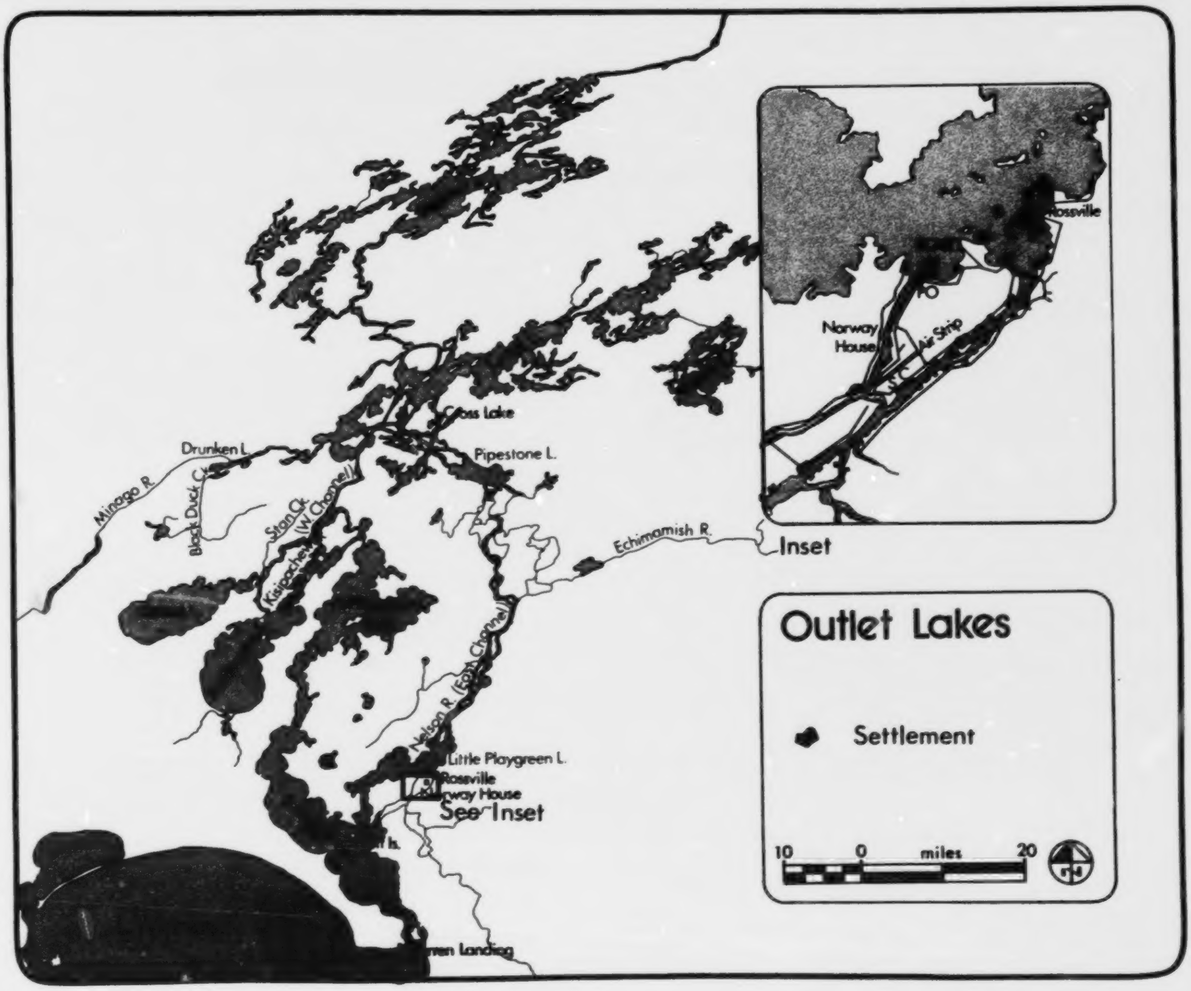

Cross Lake
Drunken L.
Pipestone L.
Minago R.
Black Duck Ck.
Stan Ck.
Kisipachew (W. Channel)
Echimamish R.
Nelson R. (East Channel)
Little Playgreen L.
Rossville
rway House
See Inset
ren Landing
Rossville
Norway House
Air Strip
Inset
Outlet Lakes
Settlement
10
0
miles
20

Fig. 6-41. Norway House-Rossvile Community, 1971.

THE ECONOMY - Trapping and fishing are the most important sectors of the Norway House economy in terms of employment and income. While employment in trapping has declined in recent years, over the period 1967-68 to 1972-73, an average of 130 men annually trapped in the Norway House registered trapline section. The average annual gross value of community production for this period was $48,408 and the average net income was $19,363 (Fig. 6-42). The summer fishery on

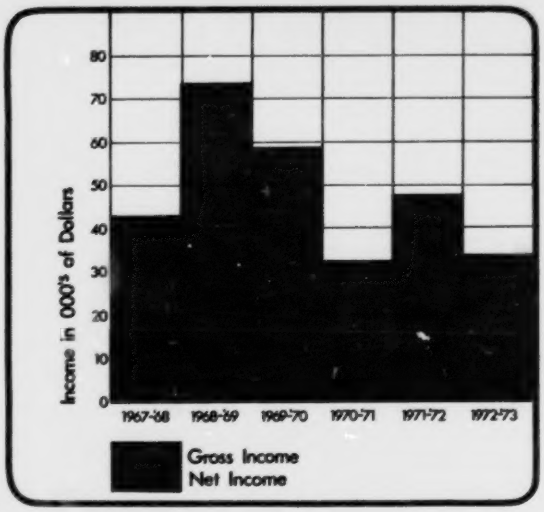


Fig. 6-42.
Gross Value and Net Income of Fur Harvested Over the Period 1967-68 to 1972-73 by Norway House Trappers.

Playgreen Lake and, periodically, on other small lakes, provided seasonal employment for an average of sixty-five men and generated an average annual net income of $72,000 between 1969 and 1973. The fishermen are presently organized in the Norway House Fishermen's Co-op Ltd. The Co-op maintains packing stations at Tait Island in the north basin of Playgreen Lake and in the south basin of Playgreen Lake at Flett (Sandy) Island. The main commercial species is whitefish. Fish are transported by boat to Grand Rapids and then by road to the Freshwater Fish Marketing Corporation Plant in Transcona, Manitoba. No commercial winter fishing has been undertaken by Norway House residents in recent years.

EFFECT ON THE ECONOMY - It is anticipated that only the fishing and trapping sectors of the Norway House economy will be affected by the regulation project.

There are nine trapping blocks within the Norway House registered trapline section which will probably be affected to a minor degree by the Lake Winnipeg regulation project (Fig. 6-43). Over the period 1967-68 to 1972-73, an average of eighty-two trappers were annually employed on these blocks, and the gross value of the fur harvested averaged $12,000 annually. The relatively small increase in water levels along the East Channel combined with the reduction in the range of fluctuation that will occur with regulation is not anticipated to cause a significant reduction in harvest. However, blocks 25,31,36 and 29 have incurred severe short-term losses due to construction work in the area over the last 2 years. After construction is completed, it is expected that furbearer populations will return to pre-construction activity levels.

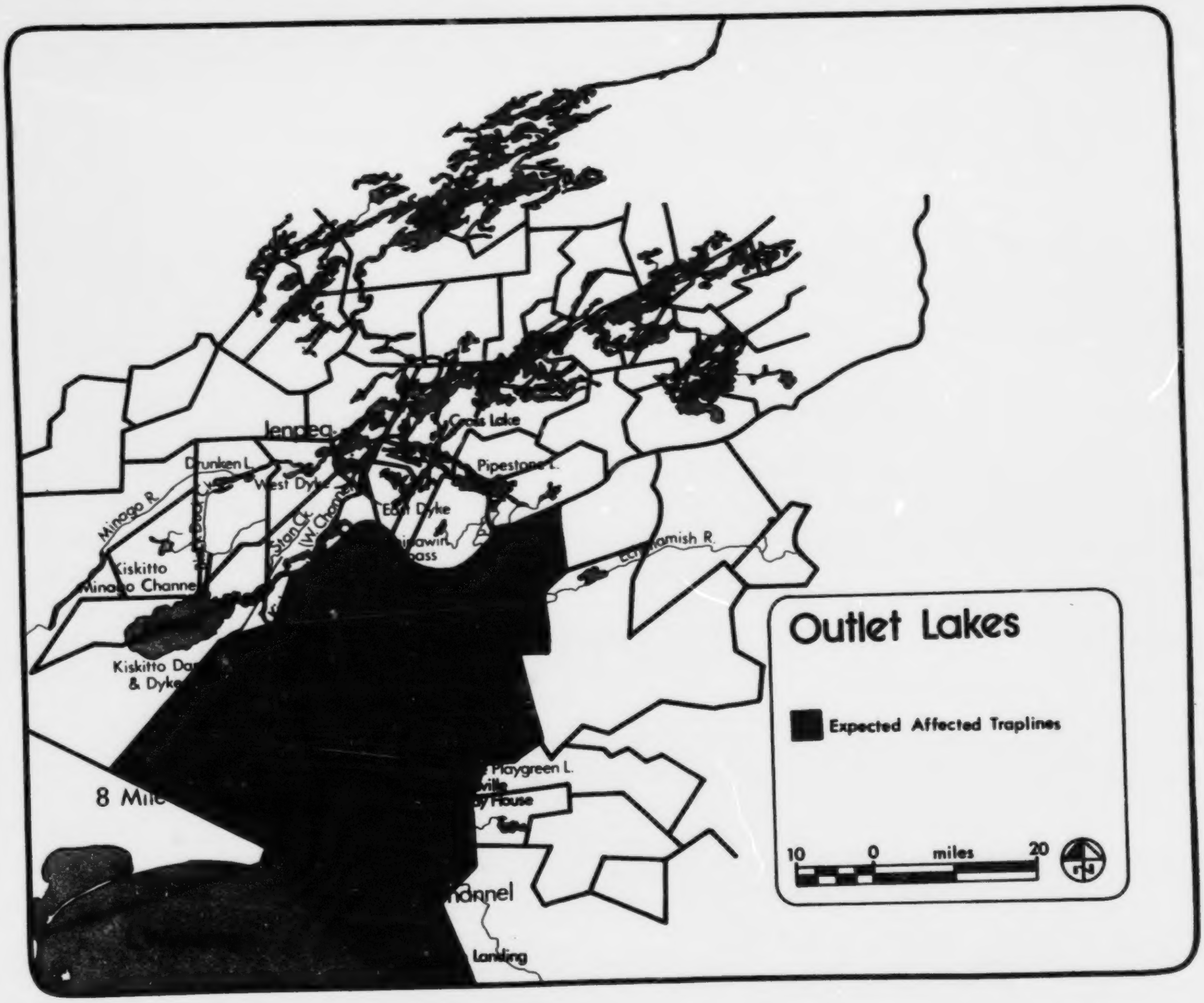

Jenpeg
Cross Lake
Drunken L.
West Dyke
Pipestone L.
Minago R.
Stan Ck.
(W. Channel
East Dyke
Kiskitto
Minago Channel
Echoamish R.
Kiskitto Dam & Dyke
Playgreen L.
House
8 Mile
Channel
Landing
Outlet Lakes
Expected Affected Traplines
10
0
miles
20

Fig. 6-43. Norway House Trapping Blocks Expected to be Affected by the Lake Winnipeg Regulation Project.

The effects of the Lake Winnipeg regulation project on the fishery has been difficult to assess. Scientific investigations have specified two potential problem areas: increased sedimentation resulting in possible reduction of spawning success; and, changes in fish migration patterns. It is difficult to translate these potential resource impacts on productivity into precise economic effects. Nevertheless, there will possibly be some short-term disruption of commercial fishing after regulation. If migration patterns shift, there will be a period of time when production will drop while fishermen attempt to find new fishing areas. Further, losses in production due to disruption of spawning grounds may become apparent in the later 1970's as fish which spawned in 1974, 1975 and 1976 reach commercial size.

THE LABOUR FORCE - The labour force of Norway House is estimated to be approximately 900 people. Besides the seasonal employment provided by trapping and fishing, the major employer in the community is the government. The hospital, airport and general administration provide approximately ninety to one hundred jobs. In addition, approximately fifty jobs are available in the private service sector (retailing, telephone). Local construction projects have provided sporadic employment opportunities.

EFFECT ON THE LABOUR FORCE - Although there have been substantial job opportunities available because of the construction work associated with the regulation project, only a few Norway House residents have taken advantage of these opportunities. On average, only five to ten residents have been employed at one time, although this figure has been much higher in some months. Most of those employed have been unskilled construction workers or bush cutters on timber clearing operations. The reason for the relatively small response to these job opportunities is not clear, but is probably related to easy accessibility of social assistance, and an aversion to working away from the community because of strong social and family ties, combined with the availability of employment on government sponsored local work programs.

EFFECT ON COMMUNITY INFRASTRUCTURE - Real property damage, including those to transportation facilities and services, will probably be minimal. Since water levels under regulated conditions will not exceed historic fluctuations, there is only a remote possibility of property damage within the community. The fish packing building located on Flett (Sandy) Island which has been flooded in the past will be subject to more frequent flooding, and will possibly require relocation. Discussions with local fishermen's respresentatives have indicated that a possible new site could be Mission Island.

In addition, disruption of existing winter road routes may occur. Preliminary indications are that there will be minor disruptions on the winter road to Warren Landing resulting from increased flows in the vicinity of the 2-Mile Channel.

In addition, there is a possibility of poorer ice conditions in portions of Little Playgreen Lake. This may require a re-routing of the existing winter road from Provincial Trunk Highway 6 to Norway House with a commensurate increase in the cost of construction. These impacts are of particular importance because there is no other land-link available to the community.

# SUGGESTED MEASURES FOR THE OUTLET LAKES AREA TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE LAKE WINNIPEG REGULATION PROJECT

During the course of their investigations in the Outlet Lakes area, contracting agencies suggested ways to lessen the detrimental effects and to enhance the overall benefits of the Lake Winnipeg regulation project. Some of these suggestions were examined in depth and the results along with recommendations for action were reported by the Study Board to the ministers responsible. However, time and funding constraints prohibited investigation of all suggestions in detail. These measures have been assessed according to whether they will mitigate or enhance effects of the regulation project. The results, presented in Table 6-9, will serve as a rough guide to those responsible for examining mitigation and enhancement measures.

## TABLE 6-9

## SUGGESTED MEASURES FOR THE OUTLET LAKES AREA TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE LAKE WINNIPEG REGULATION PROJECT

| | ● Fish Populations | ○ Efficiency of Harvesting | ● Wildlife Populations | ○ Efficiency of Harvesting | ● Forest Resources | ○ Utilization of Forest Resources | ● Mineral Resources | ○ Utilization of Mineral Resources | ● Outdoor Recreation Resources | ○ Utilization of Outdoor Recreation Resources | ● Knowledge of prehistorical and historical cultures | ● Transportation-Navigation services and facilities. | ○ Utilization of Trans-Nav. services and facilities | ● Cross Lake Community Income | ● Employment of People from Cross Lake | ● Maintain Traditional Life Styles at Cross Lake | ● Efficiency of the Social System at Cross Lake | ● Community Infrastructure at Cross Lake | ● Norway House Community Income | ● Employment of People from Norway House | ● Maintain Traditional Life Styles at Norway House | ● Efficiency of the Social System at Norway House | ● Community Infrastructure at Norway House |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Manitoba Hydro make known the effects of the Lake Winnipeg regulation to the residents of Cross Lake and Norway House. | | | | | | | | | | | | | | | | | M | | | | | M | |
| * Manitoba Hydro complete its program of advising holders of land entitlements, mining claims, timber permits, etc. of anticipated flooding. | | | | | | | | | | | | | | | | | M | | | | | M | |
| * Hunting and fishing activities of construction workers be controlled if necessary to ensure stocks for local people traditionally dependent on these populations for sustenance. | | | | | | | | | | | | | | M | | | | | M | | | | |
| * Manitoba Hydro modify the outlet control works design for Black Duck Creek. | E | | E | | | | | | M | | | | | | | | | | | | | | |
| * Protect the vicinity of the Minago River crossing of the Jenpeg road from intrusions for gravel and borrow pits. | | | | | | | | | M | | | | | | | | | | | | | | |
| * A tree buffer zone be maintained around borrow pits and between roads and transmission lines. | | | | | | | | | M | | | | | | | | | | | | | | |
| A control structure and associated channel improvements of the outlet of Cross Lake should be constructed. | M | M | M | | | | | | | | | M | M | | | M | | M | | | | | |
| Landing and boat launching approaches should be provided at intervals of 3 miles, along the navigation channels, by clearing and grubbing strips 200 ft. wide. | | M | | | | | | | M | | | M | M | | | | | | | | | | |
| Provide an historic museum at Norway House. | | | | | | | | | | E | | | | M | M | | | E | E | E | | | E |
| Construct a fish attraction and holding device at Jenpeg. | M | | | | | | | | | | | | | | | | | | | | | | |
| Provide bank protection at the entrance to 2-Mile Channel. | M | | | | | | | | | | | | | | | | | | | | | | |
| Following completion of construction activities, temporary buildings should be removed and all debris incinerated. | | | | | | | | | M | | | | | | | | | | | | | | |
| Revegetate the areas of all channels where spoil has been deposited. | | | | | M | | | | M | | | | | | | | | | | | | | |
| An all-weather road be built connecting the Cross Lake community road network with the Jenpeg access road. | | E | | | | | | | | E | | E | | E | E | | | | | | | | |
| A temporary fish handling station, docking facilities and a regular truck pick-up at the mouth of the Minago River for trucking commercial fish to Wabowden be established. | | E | | | | | | | | | | | | | | M | | | | | | | |
| The levels of Cross Lake be managed within a fluctuation range of 2 ft during the November-December flow cut-back period at Jenpeg. | | M | M | | | | | | | | | M | M | | | M | | | | | | | |

LEGEND

M The suggested measure has the potential to cause the factor to approach the state it was prior to the Regulation of Lake Winnipeg.

E The suggested measure has the potential to increase the factor to a state greater than it was prior to the Regulation of Lake Winnipeg.

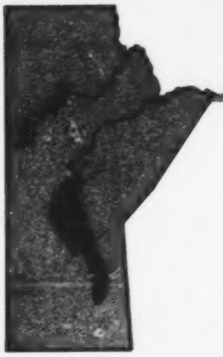
* Measures Recommended to the Ministers by the Study Board during the Course of the Study.

# FOOTNOTES

[6-1] The Saskatchewan-Nelson Basin Board was established in 1968 under an agreement among the governments of Canada, Manitoba, Saskatchewan and Alberta to study the water resources of the three prairie provinces. The Board submitted a final report in 1972.

[6-2] Azman Azis, George S. Barry and Ian Haugh. "The Undiscovered Mineral Endowment of The Canadian Shield in Manitoba", Mineral Bulletin MR 124, Mineral Resources Branch, Department of Energy, Mines and Resources, Ottawa, Publication 72-1, Mines Branch, Department of Mines, Resources and Environmental Management, Manitoba, Information Canada, Ottawa, 1972.

[6-3] Local resident has been defined in the relevant collective agreements as a person who has "...resided in census division sixteen (16) and census division nineteen (19), north of the Winnipeg River system, in Manitoba, for a period of five (5) years accumulating or more immediately prior to initial hiring".



# chapter 7

# area 3
# diversion route

## GEOGRAPHY

### LOCATION

The Diversion Route has been defined for purposes of this study as the area between the intersection of the South Bay-Issett Lake diversion channel and South Bay on Southern Indian Lake, and the western edge of Split Lake (Fig. 7-1). The route is approximately 260 miles long and connects the Churchill River with the Nelson River. The area contains a number of lakes: Issett, Karsakuwigamak, Pemichigamau, Rat, Mynarski, Misinagu, Notigi, Wapisu, Threepoint, Footprint, Wuskwatim, Opegano, Birch Tree, Ospwagan, Mystery, Moak, and Appussigamasi; and rivers: Rat, Reading, Footprint and Burntwood.

As mentioned in a preceding chapter, the Diversion Route will be affected by the Churchill River diversion project and by the proposed generating stations at Wuskwatim, Manasan and First Rapids. While investigations focused on the diversion project, studies also identified the effect of these future hydroelectric projects on the Diversion Route. The effect of these future projects is presented along with the effect of the diversion project under the relevant sections of this chapter.

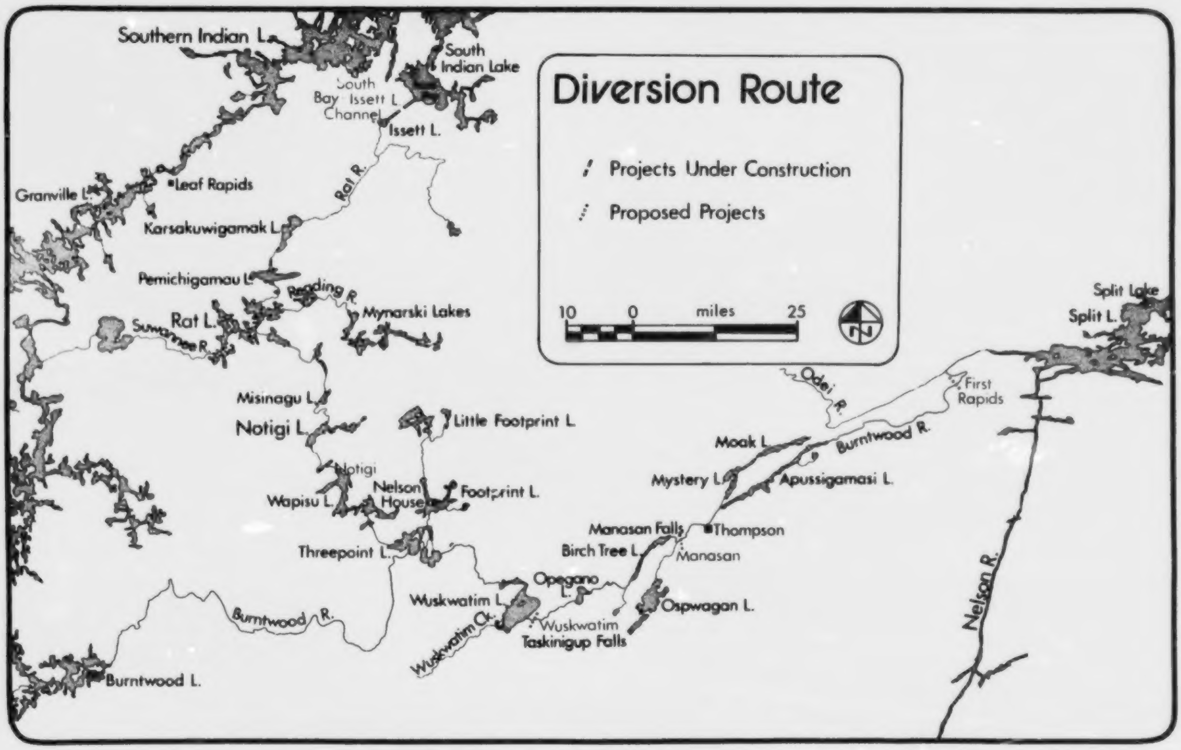

Diversion Route
Projects Under Construction
Proposed Projects
10 0 miles 25
Southern Indian L.
South Indian Lake
South Bay Issett L. Channel
Issett L.
Rat R.
Granville L.
Leaf Rapids
Karsakuwigamak L.
Pemichigamau L.
Reading R.
Mynarski Lakes
Rat L.
Suwannee R.
Misinagu L.
Notigi L.
Little Footprint L.
Notigi
Nelson House
Footprint L.
Wapisu L.
Threepoint L.
Burntwood R.
Wuskwatim L.
Wuskwatim Ch.
Opegano L.
Wuskwatim
Taskinigup Falls
Manasan Falls
Thompson
Birch Tree L.
Manasan
Ospwagan L.
Mystery L.
Moak L.
Apussigamasi L.
Burntwood R.
Odei R.
First Rapids
Split Lake
Split L.
Nelson R.
Burntwood L.

Fig. 7-1. Map Showing the Location of Area 3 - Diversion Route.

## CLIMATE

The climate of the Diversion Route area is characterized by cold winters, very short, cool summers, and brief springs and autumns. The average temperatures in January and July are -13° to -16°F and 56° to 61°F respectively. Average frost free season is approximately 80 days. Average annual precipitation is approximately 17 inches of which 6 to 8 inches fall as rain in May, June and July. Annual snowfall is 44 to 48 inches.

## PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL

The Diversion Route lies entirely in the Churchill province of the Precambrian shield. The bedrock of the area is Precambrian, consisting mainly of granitic rocks and wide belts of gneissic and volcanic rock. Relief along the route is low. Topography is mainly controlled by bedrock. Muskeg areas are common and lakes are frequent.

The area between Issett Lake and Pemichigamau Lake consists of thick organic deposits over a glaciolacustrine clay plain deposited by glacial Lake Agassiz.

Permafrost is found in the lower slopes and flatlands in both clay and organic deposits.

Between Pemichigamau and Notigi lakes relief increases rapidly. Organic deposits are deeper and there is less exposed bedrock around Rat Lake. Permafrost occurs through this area, but is most frequent in peat deposits around Notigi Lake.

Relief is moderate to low from Notigi to Threepoint lakes and bedrock outcrops are common. Permafrost is found only in organic deposits.

Relief is generally low between Threepoint and Wuskwatim lakes. Peat accumulations are common over the deep lacustrine deposits. Permafrost is found extensively in peat deposits and in some mineral soils.

From Wuskwatim Lake to a few miles west of Thompson topography is low. However, from Thompson east to Split Lake, relief gradually increases as exposed bedrock becomes more frequent and glaciofluvial deposits become prevalent.

## VEGETATION

While northern coniferous forests of predominately black spruce (*Picea mariana*) dominate this area, forests along both the Rat and Burntwood rivers have been influenced a great deal by fires. Balsam poplar (*Populus balsamifera*) and white birch (*Betula papyrifera*) are the most common species in burned areas.

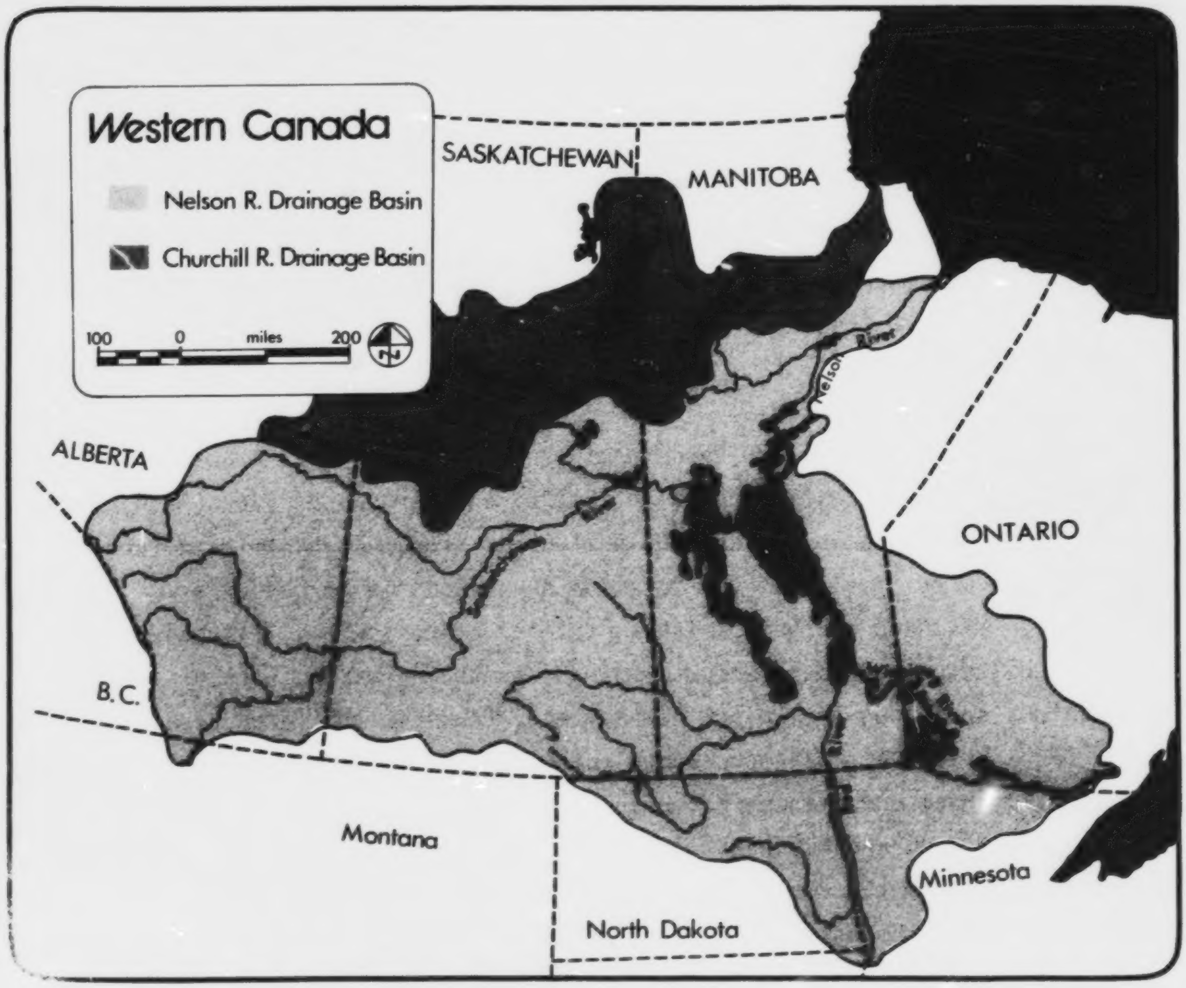
Between Misinagu and Notigi lakes, extensive erosion has left only a thin layer of soil over bedrock. Scrub growth of trembling aspen (*Populus tremuloides*), alder (*Alnus* sp.) and white birch are commonly found in this area. Jack pine (*Pinus banksiana*) and black spruce are interspersed among the deciduous growth. Grasses (*Graminae*) and lichens cover the ground.

Between Notigi and Wuskwatim lakes, bedrock control is evident. Drainage is generally good, and the vegetation is dense, unless influenced by fire or poorly drained alluvium. Forests around Opegano and Birch Tree lakes are generally open coniferous types.

Most of the forest in the Apussigamasi to Split lakes area is largely the regenerative type as a great deal of the area has been burned. Closed coniferous forest, with black spruce predominating, is found where there have not been any fires.

## DRAINAGE PATTERNS

The Churchill River diversion project will change the natural drainage patterns in the affected areas. Prior to implementation of the diversion project, the minimum distance between the Churchill River drainage basin and the Nelson River drainage basin was approximately 6 miles (Fig. 7-2). With the diversion project, the two drainage basins will be connected by a channel between South Bay and Issett Lake.


Western Canada
░ Nelson R. Drainage Basin
▨ Churchill R. Drainage Basin
100 0 miles 200
N
SASKATCHEWAN
MANITOBA
ALBERTA
ONTARIO
B.C.
Nelson River
Montana
North Dakota
Minnesota

7-2. Map Showing the Drainage Basins of the Churchill and Nelson Rivers Prior to the Diversion Project.

The two major river systems forming the Diversion Route are the Rat River he Burntwood River. The Rat River is approximately 110 miles in length and s an area of 2530 square miles. The Rat River flows into the Burntwood r at Threepoint Lake. The Burntwood River system which includes the Rat

River, drains an area of approximately 9870 square miles. Both the Rat and the Burntwood rivers begin in lakes which are very close to the Churchill River system. Issett Lake, located at the upper end of the Rat River system, is approximately 8 miles from South Bay, and Burntwood Lake, the headwaters of the Burntwood system, is situated near Flatrock Lake on the Churchill River.

## HUMAN HABITATION

There are two permanent communities in the Diversion Route area; Nelson House and Thompson. The population of the area is approximately 23,250, with 1250 in Nelson House and 22,000 in Thompson.

The community of Nelson House is located on the north shore of Footprint Lake approximately 40 miles west of Thompson. About 90 percent of the population is Registered Indian. The remainder are non-Registered Indian people and a small group of transient professional persons, mainly in the health and educational fields.

The townsite of Thompson was established by the International Nickel Company of Canada Limited (INCO) in the late 1950's. Much of the community infrastructure including roads, sidewalks, schools and a fire station were built by INCO and given to the community. Thompson was proclaimed a city in 1970.

Access to the Diversion Route area is provided by road and air. Provincial Road 391 is the regional all-weather road connecting the communities of Thompson, Nelson House, Leaf Rapids, and Lynn Lake with the provincial highway network (Fig. 7-3). Airstrips are located at Nelson House and Thompson. The airport at Thompson is the major air facility of northern Manitoba. It is operable day and night and under conditions of restricted visibility. Auxiliary facilities include a passenger and freight terminal as well as radio aids to navigation.

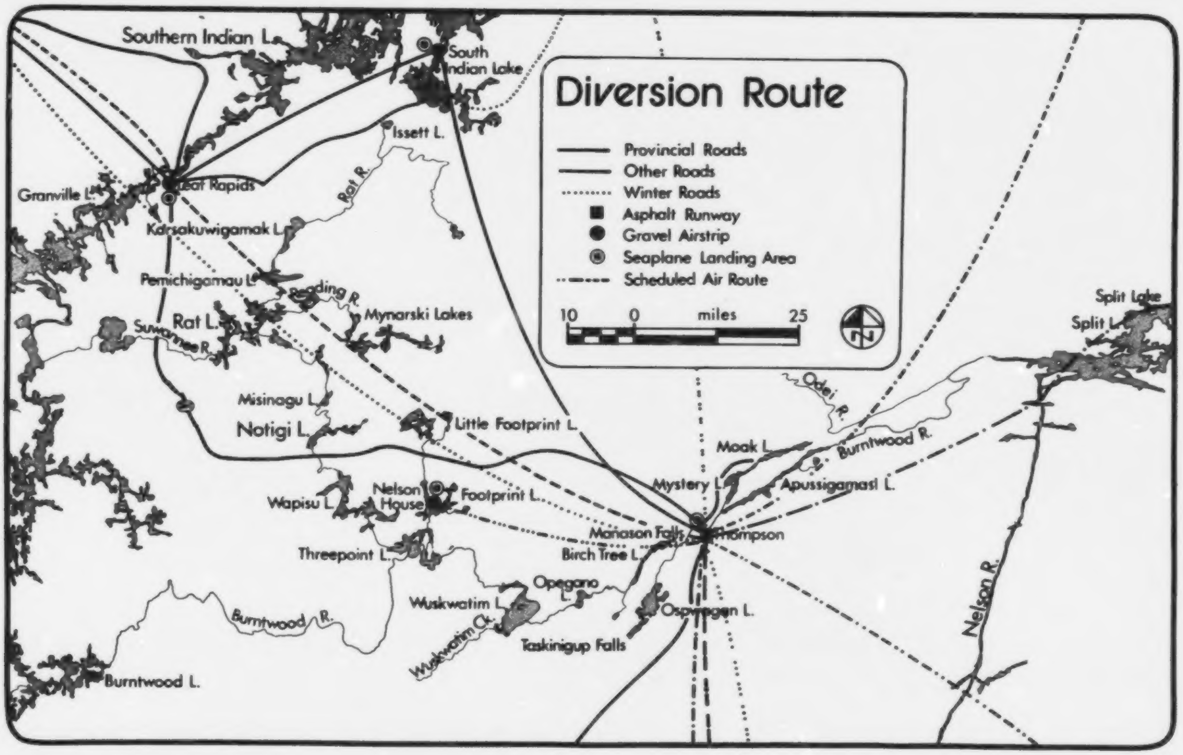

Diversion Route
Provincial Roads
Other Roads
Winter Roads
Asphalt Runway
Gravel Airstrip
Seaplane Landing Area
Scheduled Air Route
10
0
miles
25
N
Southern Indian L.
South Indian Lake
Issett L.
Leaf Rapids
Granville L.
Rat R.
Karsakuwigamak L.
Pemichigamau L.
Reading R.
Mynarski Lakes
Rat L.
Suwannee R.
Misinagu L.
Notigi L.
Little Footprint L.
Nelson House
Footprint L.
Wapisu L.
Threepoint L.
Burntwood R.
Burntwood L.
Wuskwatim L.
Wuskwatim Cr.
Opegano L.
Taskinigup Falls
Manasan Falls
Birch Tree L.
Thompson
Ospwagan L.
Mystery L.
Moak L.
Apussigamasi L.
Burntwood R.
Odei R.
Split Lake
Split L.
Nelson R.

Fig. 7-3. Map Showing Surface and Air Transportation Services and Facilities, Diversion Route, 1974.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE PHYSICAL ENVIRONMENT

## WATER REGIME CHANGES

A channel is being excavated between South Bay and Issett Lake which will connect the Churchill River drainage basin with the Nelson River drainage basin and enable the diversion of substantial flows from the Churchill River into the Rat and Burntwood rivers. The rate at which flows are diverted will be controlled by a structure at Notigi Rapids on the Rat River.

Discharge information for the period 1928 to 1966 at Notigi Rapids under pre-diversion conditions was obtained from compilations of the Saskatchewan-Nelson Basin Board,[7-1] and has been accepted by Manitoba Hydro and the Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management. As there were no man-made structures on this river system prior to the diversion project, the recorded or natural discharges have not been altered and are therefore equal to the modified historic discharges. Post-diversion discharges at South Bay were prepared by Manitoba Hydro.

The terms of the interim diversion licence issued to Manitoba Hydro by the Manitoba Department of Mines, Resources and Environmental Management stipulate that releases at Notigi cannot exceed an average weekly flow of 30,000 cubic feet per second (cfs) and that releases have to be regulated to ensure the flow in the Burntwood River as measured at Thompson does not exceed the average mean flow of 3500 cfs plus 30,000 cfs.

Prior to the implementation of the diversion project the Rat River was fed by local runoff from a relatively small drainage area. The maximum mean monthly, average mean monthly, and the minimum mean monthly flows at Notigi Rapids were 5900 cfs, 1200 cfs, and 100 cfs respectively (Table 7-1).

After diversion, the maximum mean monthly flow diverted through South Bay into the Rat River will be 30,000 cfs (Table 7-2). The average mean monthly discharge diverted at South Bay will be 26,900 cfs and the minimum mean monthly discharge will be 4000 cfs.

The average mean monthly discharges prior to diversion at Notigi Rapids have been greatest in May, June and July. With diversion average mean monthly discharges at South Bay will be greatest in September, October and November. Average mean monthly discharges at Notigi Rapids were lowest in February, March and April prior to diversion. After diversion, average mean monthly discharges at South Bay will be lowest in June.

Diversion of flows from the Churchill River into the Rat and Burntwood rivers will significantly increase water levels along this route. Analysis of these changes were undertaken by Manitoba Hydro. Water level changes were calculated for the entire Diversion Route, however, investigations focused on Threepoint Lake and the Burntwood River at Thompson.

TABLE 7-1
NOTIGI RAPIDS PRE-DIVERSION MEAN MONTHLY FLOWS

| | Jan | Feb | March | Apr | May | June | July | August | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 800 cfs | 700 cfs | 700 cfs | 1000 cfs | 4000 cfs | 5900 cfs | 4400 cfs | 4200 cfs | 3600 cfs | 2600 cfs | 1600 cfs | 1100 cfs | 5900 cfs |
| Average | 400 | 300 | 300 | 300 | 2200 | 2900 | 2200 | 1500 | 1300 | 1100 | 800 | 600 | 1200 |
| Minimum | 100 | 100 | 100 | 100 | 700 | 600 | 200 | 300 | 100 | 200 | 200 | 200 | 100 |

Note: *Based on modified historic data for the period 1928-1966.*
*Numbers have been rounded to the nearest hundred.*

TABLE 7-2
SOUTH BAY POST-DIVERSION MEAN MONTHLY FLOWS

| | Jan | Feb | March | Apr | May | June | July | August | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 30000 cfs | 30000 cfs | 30000 cfs | 30000 cfs | 30000 cfs | 28100 cfs | 29700 cfs | 30000 cfs | 30000 cfs | 30000 cfs | 30000 cfs | 30000 cfs | 30000 cfs |
| Average | 27600 | 26500 | 25800 | 24700 | 25900 | 22400 | 25500 | 28500 | 29400 | 28900 | 29000 | 27900 | 26900 |
| Minimum | 15700 | 6000 | 16100 | 6600 | 4000 | 18100 | 22700 | 26700 | 22400 | 22300 | 18000 | 15100 | 4000 |

Note: *Based on modified historic data for the period 1928-1966.*
*Numbers have been rounded to the nearest hundred.*

Threepoint Lake which covers an area of 17 square miles is relatively shallow with an average bottom elevation of 774 ft. It is connected to Footprint Lake to the north and Wapisu Lake to the west. The three lakes are at approximately the same water elevation and have a combined surface area of 50 square miles under normal summer levels. Over the past 15 years, Threepoint Lake has fluctuated from a monthly winter low of 777 ft to a summer high of 791 ft, with a mean of 783 ft. The normal annual fluctuation has been 8 ft. Under normal post-diversion conditions, the water level of the three lakes will increase by 17 ft to approximately 800 ft in the summer. However, in winter, the level can be expected to rise further to 812 ft and in a winter when ice jams are particularly severe, to 820 ft.

The flow characteristics of the Burntwood River at Thompson have been recorded by the Water Survey of Canada, Department of the Environment, since 1957. Prior to diversion, mean monthly water levels ranged from a maximum of 609 ft to a minimum of 586 ft, with an average mean monthly level of 600 ft. With diversion the average mean monthly level is anticipated to be 614 ft, the maximum mean monthly level will be 615 ft, and the minimum mean monthly level will be 610 ft.

As previously mentioned three locations, the outlet of Wuskwatim Lake, Manasan Falls and First Rapids, have been identified along the Rat and Burntwood rivers as future sites for generating stations. Planning and design of these structures are incomplete. However, preliminary calculations prepared by Manitoba Hydro show optimum forebay levels (based on energy production values) of 800, 690 and 610 ft, respectively, for the Wuskwatim, Manasan and First Rapids generating sites. These forebay levels could be as much as 10 ft higher or lower.

## ICE REGIME CHANGES

Investigations into changes that will occur in the ice regime along the Diversion Route were not undertaken by the Study. However, Manitoba Hydro funded studies which developed water and ice regime profiles for the entire Diversion Route. Changes in the water level and ice level profiles are depicted in Fig. 7-4. Extreme post-diversion high water levels could be caused by ice jam formations in the many sections of rapids along the Diversion Route. For example, Threepoint Lake normal winter levels will be approximately 812 ft and, as previously mentioned, in a winter when ice jams are particularly severe, levels could reach 820 ft. At Thompson, water levels could rise approximately 21 ft above the recorded maximum to 630 ft as a result of severe ice jams at Third Rapids on the Burntwood River approximately 32 miles downstream from Thompson.

## CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER

The chemical content of the lakes along the Diversion Route is similar to the chemical content of South Bay on Southern Indian Lake. The Diversion Route lakes are high in calcium and total carbon dioxide; features which are unusual to Precambrian shield lakes. This is a result of the weathering of glacial lake sediments overlying the Precambrian shield. Light transmission is relatively poor. This is the result of a heavy sediment load introduced by erosion of the thick clay deposits.

The Rat River provides a good supply of nutrients to the lakes along the

Diversion Route and annual nutrient loading is more than adequate at present.

The Churchill River diversion project will result in the inundation of extensive areas of land and will introduce a new supply of water with different chemical properties to the Diversion Route.

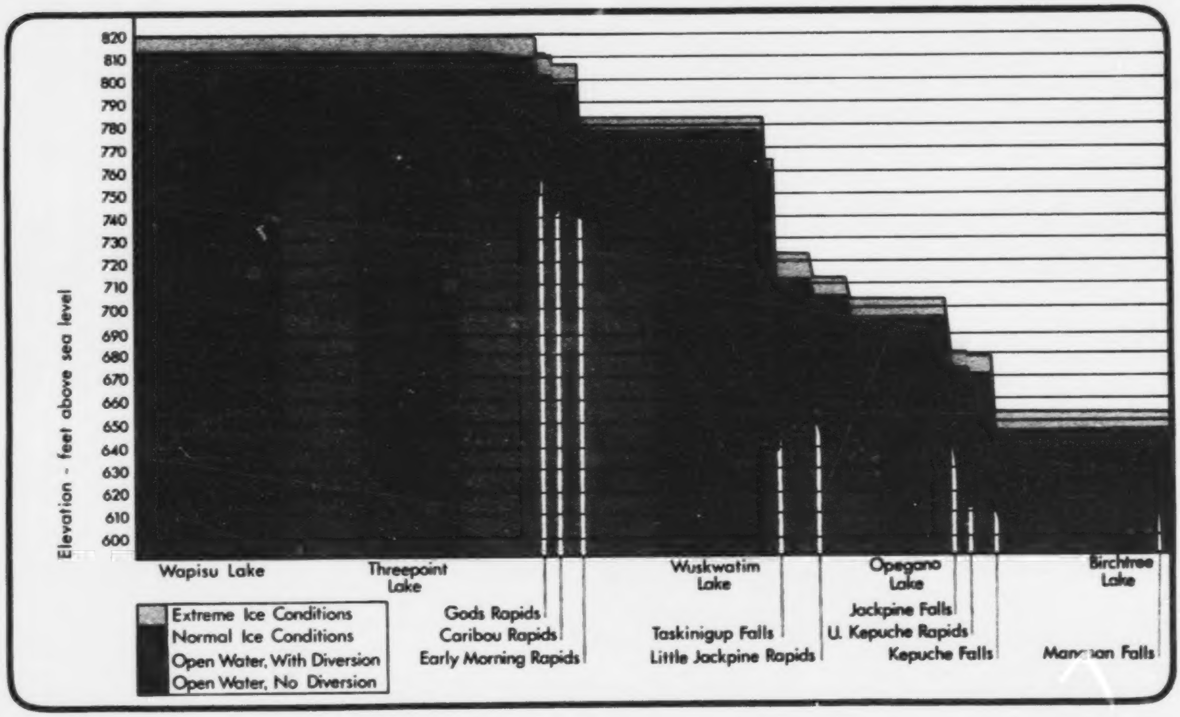


Fig. 7-4. Pre-diversion and Post-diversion Ice and Water Regime Profile of the Diversion Route.

The mean depth of the Rat-Notigi reservoir will be approximately 23 ft. Summer thermal stratification will not be extensive or prolonged as river currents and wind action will tend to keep the reservoir isothermal. However, thermal stratification is likely under ice, and the large inundated areas with biological decomposition will likely create oxygen depletions which will be especially severe in bays. Winter oxygen conditions will eventually improve as organic soils are buried by sediments or are mineralized. However, studies indicate this condition can persist more than 10 years after impoundment.

The flooding of organic soils and erosion of the shoreline will release nutrients into the water. The nutrients, even if biologically available, are unlikely to increase primary production markedly as nutrient loading by the

Churchill River will be quite high. More significant will be sediments added from eroding shorelines. This will decrease the transparency of inflowing Churchill River water which has a greater Secchi disc depth than the present Rat River. Conditions in the vicinity of the diversion channel are likely to be especially severe as the shallow depths, strong currents, and wind action will not allow materials to settle. Below the Notigi control structure where active channel cutting will occur there will be at least a four-fold increase in total suspended solids over the natural conditions and this will greatly reduce light penetration in Wapusi, Threepoint and Wuskwatim lakes.

## PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS

Construction of the Notigi dam and control works is nearing completion and impoundment has begun which will eventually create a long lake extending northward to South Bay. Below Notigi the Diversion Route will be more like a river than a lake. Thus the changes in the characteristics of the shorelines below Notigi will be significantly different from those that will occur above Notigi. Analyses of changes to shorelines were based on the diversion project and do not include the effects of proposed reservoirs at Wuskwatim, Manasan and First Rapids.

ABOVE NOTIGI - From its headwaters in Issett Lake, the Rat River meanders to Karsakuwigamak Lake. The general low relief of this area is reflected in the predominance of low shorelines. The Rat River has extensive marsh and willow shrub along its shoreline. Offshore vegetation is usually horsetail (*Equisetum*), pondweeds (*Potamogeton*) and bulrush (*Scirpus*). Sedge meadows are common.

The effect of the diversion of Churchill River waters into the Diversion Route will be greatest along the Rat River from Issett Lake to Karsakuwigamak Lake. Here the Rat River will be changed into a lake characterized by bedrock shorelines and actively eroding clay banks. Stabilization of these shorelines is expected within 30 years following diversion. However, in protected shoreline areas such as flooded bays and stream valleys the shoreline stablization process will be very slow and these areas will remain congested with standing and fallen trees.

A few miles above Karsakuwigamak Lake, the gradient of the river increases. Channel shape is very irregular. Overburden is deep and masks the shape of the underlying bedrock topography. The lakes are typically Precambrian shield riverine lakes. Shorelines are characteristically of low relief. Vegetation is generally sedges (*Carex*) and grasses (*Gramineae*) along the shore and closed coniferous forests in the backshore areas.

Water levels will increase in the upper portions of the Rat River channel by approximately 32 ft and by approximately 50 ft in the lower portions. Although the vertical level of flooding increases further south, the horizontal extent of flooding decreases due to the steeper terrain in the lower portions of the Rat River. It is anticipated the shorelines along the Rat River to Notigi Rapids will slowly evolve into bedrock shorelines. It is expected that debris and driftwood will accumulate along the shorelines and reduce the rate of erosion. Stabilization of flooded stream valleys and embayments will take more than 50 years.

Flooding will reduce the variety of shoreline types and increase the total length of the shoreline from its present length of 500 miles to 1400 miles. Marshes and beaches will be eliminated and new ones will be very slow to establish. Floating sedge matts and fens are expected to occur on Karsakuwigamak, Pemichigamau, Rat and Notigi lakes.

Approximately 158 square miles (101,484 acres) are likely to be flooded along the Diversion Route between South Bay on Southern Indian Lake and the Notigi control structure on the Rat River. Forty-eight percent of this area is timber covered, 44 percent is treed muskeg and 8 percent has no forest cover.

Manitoba Hydro has allocated a total budget of $11,000,000 for timber clearing prior to diversion from the Churchill River. Approximately $5,000,000 have been allocated for clearing along the Diversion Route between South Bay and Notigi. On 5100 acres of the area to be flooded the vegetative cover will be cut, piled and burned. Vegetation on an additional 15,500 acres will be cut and left. This clearing has been designed mainly to facilitate water flows. Most of the timber and vegetation felled and left unburned is expected to collect in bays.

BELOW NOTIGI - The waterway from Notigi to Split Lake includes portions of the Rat and Burntwood rivers and adjoining lakes. Major lakes draining into the system are: Footprint and Burntwood lakes at Threepoint Lake; Ospwagan Lake at Manasan Falls; and Mystery Lake upstream of Apussigamasi. The Burntwood River joins the Odei River approximately 8 miles upstream of Split Lake.

The Rat and Burntwood rivers flow through glacial Lake Agassiz deposits. Consequently, the majority of the shorelines and backshore areas are silts and clays overlying bedrock. In general, irregular and narrow channel sections contain bedrock shorelines while widenings in the channel and embayments contain clay banks. The clay shorelines are either sites of deposition or they are slowly eroding. Numerous scenic falls and rapids are located along the system.

Low bedrock-controlled shorelines with beach development are common on Wapisu Lake. A thin fringe of sedge and willow occurs on shore. Threepoint Lake has mainly low bedrock shorelines, although 38 percent of the shoreline is a low sediment type. Beaches are common on Threepoint Lake. About one-half the shoreline of Wuskwatim Lake is bedrock-controlled, with low alluvial and marsh types comprising the remainder.

Opegano and Birch Tree lakes are situated in very deep deposits of lacustrine material and slumping shorelines are common. Although small in total area, marsh development is more extensive in Birch Tree Lake than it is in Opegano Lake. The Burntwood River in this area is mostly bedrock-controlled.

Apussigamasi Lake is largely bedrock-controlled, but there is heavy overburden in embayments. There are a few miles of sedge-willow development associated with the low shorelines on Apussigamasi Lake. The river channel to Split Lake rests on bedrock. Thick lacustrine deposits are present. Marshes are infrequent and usually occur in bays.

After the diversion of flows from the Churchill River and regulation at the Notigi control structure, the mean discharge in the Burntwood River will be increased nine to ten-fold. The impact on lakeshores underlain by bedrock will be one of erosion until bedrock is reached. Such shorelines will remain indefinitely recluttered with fallen trees. Embayments and other protected shorelines will remain congested with standing dead trees. Sand beaches and marshes will be inundated and will not redevelop to the extent they were in the natural state. Steep clay banks will continue to erode, although at an accelerated rate. These shorelines will likely appear much as they did in the natural state. Steep bedrock shorelines will not be significantly altered.

The physical processes along the river channel will be accelerated because of the increased rate of flowing water and moving ice on vegetation and materials. In general, an increase in discharges will bring about an increase in channel size, both vertically and laterally.

Each shoreline type will be affected differently. Little change will occur where bedrock controls the channel width but clay shores may recede approximately 60 to 70 ft on either side. The main difference between riverbanks and lakeshores is the removal of flooded and fallen trees. Riverbanks will not likely contain the amount of dead standing trees that will typify protected lakeshores.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE RESOURCE BASE AND ON RESOURCES UTILIZATION

## LIMNOLOGY AND FISHERIES

LIMNOLOGY - Lakes along the Rat and Burntwood rivers are, in general, relatively small. They vary in size from Issett Lake with a surface area of 1.4 square miles to Rat Lake with an area of 33 square miles. The small size of the lakes permit a relatively rapid exchange time (less than two months for all lakes except Rat Lake).

There is no significant thermal stratification of these lakes in summer. The isothermal condition, particularly in the Rat River lakes, is probably the result of the strong mixing action of the turbulent flows in the riverine sections of the system and of wind action on the lakes. Isothermal conditions and high rates of exchange provided conditions of near or total oxygen saturation in the Rat River lakes during the summer months. During the winter, thermal stratification occurs and the oxygen content of deep water is reduced.

Despite a high silt load, algal production in the Diversion Route lakes is relatively high. Values recorded for algal biomass during August exceed maximum values recorded for Southern Indian Lake and values found for the lakes and reservoirs on the Nelson River. The quantities of crustacean plankton in the lakes of the Rat and Burntwood rivers system are comparable to the abundances found in Lake Winnipeg. The species composition is similar to most shield lakes with *Cyclops vernalis, Diaptomus oregonensis, Diaptomus ashlandi and Chydorus sphaericus* being the most abundant components.

Densities of benthic invertebrates are generally low although they are not unusually low for typical shield lakes. The relatively high values for algal biomass did not result in correspondingly high densities of benthic invertebrates. *Pontoporeia affinis* were not present in the samples from the Mynarski Lakes. In the remaining lakes this group along with the Chironomidae were the dominant taxa.

Whitefish (*Coregonus clupeaformis*), walleye (*Stizostedion vitreum*), and northern pike (*Esox lucius*) were the commercial fish species present, with walleye predominating in number more often that whitefish.

Although detailed investigations into the location of spawning sites for the major commercial fish species were not conducted, general observations were made where possible and recorded. Spawning sites for whitefish are generally clean rock or boulder areas in lake shallows. Prior to diversion and impoundment, this type of habitat existed in varied locations along the Diversion Route. Indications are that walleye within the Diversion Route are stream spawners. One major river entering the Rat River system, the Reading River, was identified as being highly utilized by spawning walleye. In addition, a large number of other tributaries to the Rat River system are probably used by spawning walleye.

EFFECT ON LIMNOLOGY - The flooding of organic soils and erosion of the shoreline will release nutrients into the water. The nutrients, even if biologically available, are unlikely to increase primary production markedly as nutrient loading by the Churchill River will be quite high. More significant will be sediments added from eroding shorelines. This will decrease the transparency of diverted Churchill River water which has a greater Secchi disc depth than the present Rat River. Conditions in the vicinity of the diversion channel are likely to be especially severe as the shallow depths, strong currents, and wind action will not allow materials to settle. Below the Notigi control structure where active channel cutting will occur there will be at least a four-fold increase in total suspended solids over the natural conditions and this will greatly reduce light penetration in Wapisu, Threepoint and Wuskwatim lakes.

An increased sediment load will adversely affect algal production above Notigi. Until some measure of shoreline stabilization is reached and the reservoir begins to clear, algal production on a per-unit-area basis will remain lower than its level prior to diversion and impoundment. Below Notigi, algal production will decrease in proportion to the large increase in suspended sediments. As a result of increasing flushing rates the crustacean plankton will decrease in numbers, particularly in the lakes below Notigi.

The areas exposed during winter drawdown will be relatively unsuitable for colonization by benthic invertebrates; however, in other areas the additional nutrients and organic materials in the modified environment will support substantial populations. In general the production of zoobenthos on a per-unit-area basis will increase and will likely eventually equilibrate at levels similar to those presently found in the lower Churchill River lakes.

Relative population sizes of different species of fish will change considerably. Whitefish spawning habitat will be restricted to those areas appearing now as rock outcrops until shoreline stabliization occurs and clear rock areas are available at the optimum depths. While whitefish will not disappear, their numbers on a per-unit-area basis will be reduced.

Streams suitable for spawning walleye will, in most cases, be completely inundated. The significant reduction in availability of spawning habitat will reduce numbers of walleye at least temporarily. Below Notigi, walleye may move to the tailrace area of the control structure, particularly during the time of spawning. This concentration would become attractive to sports fishermen.

The new reservoir will create large areas of excellent northern pike spawning habitats, i.e., areas of standing vegetation in lake shallows. In addition typical northern pike food (small fish) will be available in good quantity. The new reservoir should become, therefore, an excellent source of northern pike, (as is the case in Sipiwesk Lake).

## FISHERIES

Commercial Fishery - The following lakes along the Diversion Route have commercial fishing quotas for whitefish and pickeral: Pemichigamau, Rat, Notigi, Wapisu, Wuskwatim, and Mynarski lakes. The total quota for these lakes is 175,000 lbs. The quota for each lake is given in Table 7-3.

Commercial production on these lakes has been intermittent, and Pemichigamau and Wapisu lakes do not have recorded landings. A summary of the commercial production over the last few years on these lakes is given in Table 7-3.

The average yield ranges from 6.9 lbs per acre on the Mynarski Lakes to 1.63 lbs per acre on Notigi Lake. Whitefish comprise 71 to 85 percent of the catch with the remainder being made up of walleye and pike.

For the last 3 years production from these lakes has been well below their capacities. The yields per acre have been high indicating that the lack of production is probably not due to lack of fish but rather to lack of effort by fishermen. On the average, thirty-eight commercially licensed fishermen from Nelson House fished these lakes. The small quotas and the great distance to handling facilities may contribute to the limited effort exerted. Prior to 1972 the production from these lakes was flown to Thompson and from there taken to Winnipeg by rail. In 1972, these lakes came under the jurisdiction of the South Indian Lake Co-op Fisheries Ltd. and the procedure was changed. Generally, fish are iced on the lake, flown to Leaf Rapids, processed, and transported by truck via Provincial Road 391 to Leaf Rapids. The Nelson House harvest is shipped with the Southern Indian Lake fishery harvest to Winnipeg.

TABLE 7-3
SUMMARY OF COMMERCIAL FISHERIES QUOTAS AND PRODUCTION ON THE DIVERSION ROUTE LAKES, 1970-72

| LAKE | QUOTA | PRODUCTION | | |
|---|---|---|---|---|
| | | 1970 | 1971 | 1972 |
| Pemichigamau | 10,000 lbs. | | | |
| Rat | 45,000 | 39,500 lbs. | | 38,600 lbs. |
| Notigi | 10,000 | | | |
| Wapisu | 30,000 | | | |
| Wuskwatim | 40,000 | 24,800 | 2,400 lbs. | |
| Mynarski Lakes (east) | 15,000 | | | 500 |
| Mynarski Lakes (west) | 25,000 | | | 500 |
| Total | 175,000 | 64,300 | 2,400 | 39,600 |
| Percentage of Total Quota | | 37% | 1% | 23% |

Domestic Fishery - The extent of the domestic fishery was not investigated. Residents of Nelson House fish neighbouring lakes for their own consumption. The quantity does not appear to be large enough to adversely affect commercial fishery yields.

Sport Fishing - There is no concerted sport fishery at present. There are no facilities and very few tourists come to the area. Local residents, mainly from Thompson, do some sport fishing in the Diversion Route area.

## EFFECT ON FISHERIES

Effect on Commercial Fishery - The effect of the Churchill River diversion project on the commercial fishery will be extensive. The large areas of flooded timber will make it impossible to utilize gillnets in the lakes along the Diversion Route. Gillnets will be damaged by floating and sunk debris. In addition, access to the shoreline will be hazardous as in many areas there will be as much as 2 miles of flooded timber between the existing shoreline and the post-diversion shoreline. Navigation will be difficult and hazardous. The present fish camps on Rat, Notigi and the Mynarski lakes will be flooded and the building of new camps will be hampered by the inaccessibility of the new shorelines. These factors will probably result in an initial reduction of 90 to 100 percent in the size of the fishery. The commercial fishery is not likely to be viable until the new system has stabilized which will probably require more than 10 years and maybe as much as 50 years.

Effect on Sport Fishery - Walleye may move to the tailrace of the Notigi control structure, particularly during spawning, thus providing a concentration ideal for sport fishing. The Notigi reservoir will create large areas of excellent spawning habitat (standing vegetation in shallows) for northern pike. Pike food (small fish) will still be available in sufficient quantity and the reservoir will support a large pike population which will include many individuals of trophy size.

## WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE

Habitat along shorelines in the Diversion Route area varies from long stretches of steep bedrock shoreline to extensive areas of marsh. Diversion of water from the Churchill River will significantly change shorelines along the Diversion Route. These changes will affect wildlife populations.

## WILDLIFE HABITAT AND POPULATIONS

Ungulates - The limited information available on moose (*Alces alces*) suggests that moderately severe environmental conditions and generally poor habitat combine to produce generally low populations in the Diversion Route area. Although moose densities in some localities may be higher in winter, a density of between 0.25 and 0.5 moose per square mile for the area appears to be reasonable estimate.

The willow (*Salix* spp.) shorelines of the upper Rat River from Karsakuwigamak Lake to South Bay may have a density as high as 0.5 moose per square mile. The area around Birch Tree Lake and Thompson may also have a density as high as 0.5 per square mile.

The Diversion Route area contains potential winter range for barren-ground caribou (*Rangifer tarandus groenlandicus*). Winter range areas are characterized by black spruce forests with lichens and deciduous shrubs. In the 1940's and 1950's when populations were high, barren-ground caribou winter migrations penetrated south of their present winter range and part of the Diversion Route was utilized.

The Diversion Route area also represents potential woodland caribou (*Rangifer tarandus caribou*) range. Good quality habitat areas for these caribou feature mature black spruce and jack pine stands interspersed with upland bogs. These areas contain a suitable combination of cover and food for critical winter periods. Food preferences include arboreal and ground lichens, various shrubs and sedges. Burned over areas usually do not support caribou populations in winter. However, the Diversion Route is at the northern extreme of woodland caribou range and there is no information to suggest that woodland caribou use any part of this area during the summer. However, evidence of woodland caribou activity was noted at the southern edge of Rat Lake on a winter survey flight.

Furbearers - In terms of both economic value and numbers, the major species in the Diversion Route area are beaver (*Castor canadensis*), lynx (*Lynx canadensis*), mink (*Mustela vison*) and muskrat (*Ondatra zibethicus*).

The Diversion Route lies in a region of medium to heavy beaver density. This is due to the relative abundance of suitable food trees, such as poplar and willow. These are the principal sources of food and building materials for beaver in northern Manitoba. Shoreline type has little direct relation to distribution of beaver. This animal prefers small creeks, ponds and channels leading into the rivers and lakes along the Diversion Route. High fur returns of the area reflect high beaver populations. Densities may approach one lodge per square mile, with a probable range of 0.5 - 1.1 lodges. Interviews with trappers from the area indicate each lodge can house seven to eight beaver.

Lynx are indirectly dependent on shorelines through the availability of prey species; primarily the snowshoe hare. The predatory nature of the lynx requires that it move over large areas. Most of the Diversion Route would be utilized to some extent. The more productive riparian habitats are preferred but burned-over regions in early seral stages of regrowth are also utilized.

From interviews with trappers it appears that numbers of lynx are declining and the trough of the 10-year cycle of lynx abundance may be near. Maximum densities as high as 0.2 per square mile may have been reached several years ago.

Mink are semi-aquatic predators which favour deciduous woodlands and marshes surrounding banks of rivers, ponds, lakes and streams. Riparian habitat provides denning sites and supports adequate numbers of prey species. The marshy, low willow and medium steep sediment type shorelines are the most suitable along the Diversion Route. Low bedrock shorelines along rivers and lakes are also used. The upper Rat River from Issett Lake to Karaskuwigamak Lake contains good mink habitat. Interviews with trappers indicate that mink are also found in deciduous habitat along creeks and ponds inland from the Diversion Route.

Distribution of muskrats is directly related to marsh habitat, which is limited in this area. Precambrian bedrock predominants and extensive marsh areas are few in number. However, there are numbers of small marshes along most shorelines of lakes along the system. These marshes usually exist in small embayments where a creek enters the lake, and provide suitable muskrat habitat.

Larger areas of marsh are found in Wuskwatim Lake, at its southern and northern ends. Numerous ponds and creeks inland from the main system also provide suitable muskrat habitat. Several reaches of the Rat River with low shorelines, where flows are not as swift, have good potential for muskrat production. The upper Rat River between Karsakuwigamak and Issett lakes and the reach between Rat and Misinagu lakes provide good muskrat habitat. Aquatic vegetation is relatively abundant in these reaches and shorelines are suitable for muskrats.

Waterfowl - Nearly 90 percent of ducks observed in mid June were associated with marsh shorelines along Wuskwatim Lake, the upper Rat, and lower Burntwood rivers.

Five whistling swans (*Olor columbianus*) were seen on Karsakuwigamak and Pemichigamau lakes and the Burntwood River west of Split Lake. Only three Canada geese (*Branta canadensis*) were seen. These were on the Burntwood River between Apussigamasi and Birch Tree lakes. Two of these geese were considered to be a breeding pair.

Mallards (*Anas platyrhynchos*) and lesser scaup ducks (*Aythya affinis*) were almost even in numbers and together comprised 21 percent of all waterfowl observed. Diving ducks were twice as numerous as dabblers. The latter favoured marshy areas more than diving ducks. Other dabbling species included black ducks (*Anas rubripes*), American widgeon (*Mareca americana*), pintail (*Anas acuta*), and green-winged (*Anas carolinensis*) and blue-winged teal (*Anas discors*). Diving ducks included common goldeneye (*Bucephala clangula*) and bufflehead (*Bucephala albeola*). Both white-winged (*Melanitta deglandi*) and surf scoters (M. *perspicillata*) were observed in small numbers on Wuskwatim and Karsakuwigamak lakes.

Only six species of waterfowl showed signs of breeding along the Diversion Route. Mallards were the most numerous. Breeding birds were observed in the upper sections of the Rat River and along the Burntwood River (and its lakes) from Threepoint to Split lakes.

Mallards and lesser scaup comprised 62.2 percent of all waterfowl observed in midsummer staging flocks along sediment shorelines.

Notable concentrations of Canada geese in September were on the Burntwood River east of Apussigamasi Lake, near the mouth of Odei River, and on the Rat River between Threepoint and Wuskwatim lakes. Mallards and green-winged teal comprised 57 percent of all waterfowl observed at that time. Concentrations were observed on the Wapisu Lake and on the Burntwood River below Apussigamasi Lake. Scaup and goldeneye, mainly in small flocks on the larger lakes, comprised 11 percent of the waterfowl observed; six whistling swans were seen.

By late September, numbers of waterfowl had doubled from earlier in the month. Numbers of whistling swans were up slightly but numbers of Canada geese remained the same. Main concentrations of Canada geese continued to be seen below Apussigamasi Lake. Dabbling ducks comprised 69 percent of all waterfowl observed while divers accounted for only 16 percent. Dabblers were noticeably associated with the exposed mud banks and aquatic vegetation of the upper Rat River, lower Burntwood River and Wuskwatim Lake. Concentrations of scaup and goldeneye on Rat River comprised 43 percent of all divers seen throughout the Diversion Route.

The major importance of the Diversion Route to waterfowl would appear to be as staging habitat. Small flocks of Canada geese use some of the lakes and attractive stretches of the lower Burntwood River in fall.

EFFECT ON WILDLIFE HABITAT AND POPULATIONS - The diversion project will result in loss of habitat and displacement of moose. Barren-ground caribou and woodland caribour will lose some potential range, but effects will be minor unless their migration routes change. Furbearers will be directly affected by inundation of habitat. Furbearing animals will be displaced by rising water and will be lost to the area. They cannot be expected to find suitable habitat not already occupied by individuals of the same species.

Effect on Ungulates - The immediate effect of the project will be to flood existing browse and aquatic vegetation along shorelines, thereby eliminating some summer feeding areas for moose. All willow fringe will be lost on low shorelines. Summer carrying capacity of the area will be reduced until willows and other browse foods become reestablished. Moose will still occur, but mainly, in upland areas.

Assuming a potential density between 0.25 and 0.5 moose per square mile for the area flooded by the reservoir above the Notigi (158 square miles), there will be a loss of habitat for approximately 40 to 80 moose.

The construction of the generating stations at Wuskwatim and Manasan could mean a further loss of potential moose habitat for 20 to 40 and 15 to 25 animals, respectively. The flooding associated with the creation of reservoirs at Notigi, Wuskwatim and Manasan may result in total losses as high as 75 to 150 moose.

No major ungulate crossings have been noted along the rivers therefore the new regime should not seriously impede travel by moose.

Flooding associated with Notigi and the future control structures will result in some loss of potential winter habitat for both barren-ground and woodland caribou. While neither is dependent on shorelines they are dependent on backshore areas, such as marshes and the edges of creeks and ponds. As these areas are flooded, there will be some potential loss. However, as barren-ground caribou have not recently used this part of their winter range there will be no immediate effect. Consequences will depend upon future range extensions. At present, woodland and barren-ground caribou are not dependent on the area for winter range, but may be in future.

Secure ice conditions are necessary for the mobility of ungulates. Significant changes in water levels during winter may have an effect on caribou using the ice surface of lakes, but the consequence of this, if any, are difficult to predict.

Effect on Furbearers - Flooding of productive furbearer habitat will occur in the reservoir area of the Notigi structure. There will also be a downstream effect from Notigi even if no other sites are developed. Increased water flows with diversion will erode shorelines. Fluctuating flows in summer may leave some beaver and muskrat colonies exposed. Suddenly increased flows may cause destruction of lodges and may result in direct mortality. Mink and lynx will be indirectly affected through the effect on prey species.

The total area of land inundated as a result of the creation of a reservoir behind the Notigi control structure will be approximately 158 square miles. Assuming densities are 2.8 to 7.7 beaver per square mile, losses of potential habitat may represent a base population loss of 450 to 1200 beaver. Additional structures at Wuskwatim and Manasan would result in potential losses of 250 to 650 and 150 to 400 beaver, respectively.

Lynx will be affected indirectly through the effect of flooding on their prey. Loss of existing shorelines will reduce the availability of hares. However, it is difficult to specify the effect this will have on lynx populations.

Some range land will be flooded and this will result in displacement of lynx. The effect on the production potential of this species can only be estimated. Assuming densities of 0.2 per square mile, flooding upstream of the Notigi control structure may result in the loss of potential habitat for 30 lynx. Total losses associated with structures at Notigi, Wuskwatim and Manasan may be as high as 60 lynx. A decline is certain to occur but may be masked by the natural decline of the lynx population in the area.

Mink will be seriously affected as this species is dependent on suitable shorelines for cover and food supply. Loss of productive shorelines such as marshes, creek mouths and low shorelines will reduce its food supply. In addition, mink will be displaced from inundated areas and the potential of the area to produce mink will be adversely affected through loss of habitat. Flooding associated with the Notigi control structure will eliminate potentially productive shorelines such as those along the upper Rat River, between Karsakuwigamak and Issett lakes.

The area of the upper Rat River and the drainage basin west of Issett Lake will be extensively flooded. This will result in a substantial loss of potential muskrat habitat. Marsh changes will result in a corresponding loss of production potential. Assuming densities of 55 muskrat per mile of shoreline, flooding behind the Notigi control structure may affect as many as 4400 muskrats. Construction of additional structures associated with hydroelectric development of the Diversion Route will result in the total number of muskrats affected being as high as 5830.

Effect on Waterfowl - All of the currently attractive nesting areas and many of the staging sites will be lost with flooding. Numbers of pairs of breeding waterfowl observed during flights in June would not indicate heavy use of breeding habitat along the Rat and Burntwood rivers. The area would appear to be more important for staging.

With inundation, many dead trees will be produced, providing nesting habitat for tree nesting species, e.g., goldeneye and wood ducks (*Aixsponsa*). Flooded timber can be highly productive of waterfowl where large expanses of shallow water occur over rich soil. Lack of nesting and loafing sites and predation by mammals are usually the limiting factors in these areas.

Features which make certain areas along the Rat and Burntwood rivers attractive to staging waterfowl include the large expanses of sedge and exposed mud flats. These features will be eliminated by flooding.

Large expanses of potentially productive lowland will be flooded throughout the Diversion Route area. The time required for aquatic vegetation to establish on these flooded areas will determine future attractiveness to waterfowl.

Waterfowl using the large, open lake areas for short migration stops will not be significantly affected by flooding.

## WILDLIFE USE

Hunting - Moose are harvested mainly by residents of Nelson House to provide meat and hides. Moose are shot along trails and waterways in summer and fall. However, a portion of the harvest may be taken by fishermen along shores such as the southwestern part of Wuskwatim Lake during summer. The time and effort required to butcher animals and transport them to Nelson House does not seem to warrant active moose hunting in winter. Most moose are hunted near Nelson House, along the Burntwood River from Threepoint to Wuskwatim lakes and along the Rat River.

Sport hunting has been confined to the area of the Burntwood River east and west of Thompson and in the Paint Lake area. In 1973 the extension and opening of Provincial Road 391 from Thompson to Leaf Rapids enabled sport hunters to enter the area. However, sport hunting is still somewhat restricted due to limited transportation.

In 1972, twenty-two moose were shot (six by sport hunters and sixteen by native hunters) and in 1973, thirty moose were shot (fourteen by sport and sixteen by native hunters). Registered Indian people from Nelson House harvested sixteen moose during 1972 and 1973. Approximately thirteen to sixteen kills is the annual minimum. Assuming that only a portion of the kills by Registered Indians are reported (perhaps 50 percent), the total annual moose kills may be higher than sixteen and possibly as high as twenty-five to thirty.

In terms of moose densities and numbers shot annually, the area below Notigi is receiving high hunting pressure. In fact, the combined subsistence and sport harvest may be over acceptable levels. Information from conservation officers on moose kill locations suggests that 19 percent of moose killed by residents of Nelson House between Notigi and Thompson are calves.

The area above Notigi receives less hunting pressure from sportsmen, except along the new roads which provide access to construction workers and residents of Leaf Rapids. Harvest of moose between Notigi and Karsakuwigamak lakes are probably low. Disturbance from construction activities is high. Data on kill locations suggest that the upper Rat River is not heavily hunted by natives.

When populations of barren-ground caribou were high in the 1940's and 1950's winter migrations extended considerably south of present winter range. Residents of Nelson House are known to have hunted barren-ground caribou during this period. The Diversion Route area contains potential winter range for barren-ground caribou and is also potential woodland caribou range. While there is no information to suggest that woodland caribou use the area during summer, they represent a potentially harvestable resource. Sport hunting of woodland caribou is permitted in the area. However, the Diversion Route is at the northern extreme of woodland caribou range and populations are low. No estimates of harvest or potential harvest are available.

Many sections of the Diversion Route have very little value to production of waterfowl due to steep, rocky or sediment shorelines and little marsh growth. The importance of the Diversion Route to waterfowl would appear to be as staging habitat. Small flocks of Canada geese use some of the lakes and attractive stretches of the lower Burntwood River in fall.

Little is known of the use made of waterfowl produced along the Rat-Burntwood rivers system. Small kills probably occur around settlements and near fishing camps. When Nelson House trappers were interviewed they indicated that they did not hunt waterfowl. Hunting is probably opportunistic and favours geese during spring and fall migrations. It is estimated that native moose hunters may kill six ducks or geese per day while hunting moose.

Little is known of the harvest by sport hunters of ducks along the Diversion

Route around Thompson. Numbers shot are probably low, as considerable travel would be necessary by boat to reach fall concentrations of waterfowl.

A discussion of hunting related to community economics is given in the community section.

Trapping - Trapping blocks along the Diversion Route belong to Southern Indian Lake, Nelson House, Thicket Portage and Split Lake Registered trapline sections. Major furbearers trapped (in value and numbers) are beaver, lynx, mink and muskrat. Beaver and lynx have accounted for over 80 percent of returns in the Nelson House section. Beaver are not directly dependent on lake shorelines along the Diversion Route but are usually found along small creeks and in ponds leading into larger bodies of waters. Most beaver trapping, therefore centres around these small creeks. Three or four beaver may be trapped from lodges which can house up to seven or eight animals.

Lynx are most abundant in the region between the Churchill and Nelson rivers, including the Rat and Burntwood rivers. However, numbers are declining and the number of lynx pelts harvested has followed this downward trend.

In terms of numbers of pelts harvested, muskrats are the most trapped species in the area. Muskrats are trapped in small marshes along rivers and lakes and in larger marshes in the Diversion Route area. Trappers who were interviewed indicated that ponds and creeks inland from the main system were the areas most frequently trapped. While muskrat habitat is generally limited in the Diversion Route area, some areas are under-utilized, such as the large marshes of Wuskwatim Lake.

Other species trapped include otter (*Lutra canadensis*), fox (*Vulpes* spp.), pine marten (*Martes americana*), red squirrel (*Tamiascuirus hudsonicus*), wolf (*Canis lupus*) and wolverine (*Gulo luscus*). Most of these furbearers are land based, but may be indirectly dependent upon shorelines.

The trapping season in the Diversion Route area begins in late October and continues until May. Individual species are trapped when pelts are prime, e.g., muskrats in spring and fall; mink, early winter; lynx, midwinter.

Travel from communities to registered traplines is time consuming, and costly. Traplines near communities are utilized to a greater extent than remote lines located northeast of Nelson House.

Information on trapping practices was obtained by the wildlife study group in interviews with trappers from Nelson House. Areas trapped in winter are mostly inland. Lake and river shorelines are trapped in the spring. Both the Rat and Burntwood rivers are vital transportation routes for trappers. Most travel between traplines and the community is along the rivers but a few overland routes are used in winter. All travel in the fall is along the rivers.

Trapping blocks are either well used or not used at all. There are large numbers of non-active trapping blocks which are usually in remote localities. Access is difficult and time consuming. Interest in trapping is declining. Some trappers are employed elsewhere and will not return to their traplines. A community trapping block near Nelson House is used by residents who do not have their own traplines.

The most productive trapping blocks along the Diversion Route are Nelson House registered trapping blocks 12, 30, 33, 39, 49, and 60; Southern Indian Lake registered trapping block 4; and Pikwitonei registered trapping block 57. The productivity of these trapping blocks is probably due to species availability, proximity to the community, and better habitat. The majority produce an average annual fur harvest return of over $2,000.

Federal-provincial government programs are being developed to increase utilization of the resource through more intensive resource management practices and trapper education. Trapper organizations, e.g., the Nelson House Trappers Association, have been formed to facilitate better fur harvest and increase co-operation with government departments. As noted, some registered trapping blocks appear to be well utilized while others are under-utilized, especially remote lines. Travel difficulties and the availability of alternative employment have reduced trapper motivation and have had to reduce harvests.

## EFFECT ON WILDLIFE USE

Effect on Hunting - The immediate effect of the project will be to flood existing browse and aquatic vegetation along shorelines and thus eliminate some summer feeding areas for moose. The summer carrying capacity of the area and opportunities for native moose harvests along shorelines will be reduced. However, moose will still be available in upland areas. Total losses associated with the Notigi, Wuskwatim and Manasan structures may be as high as 75 to 150 moose. This could result in a potential annual harvest loss of 15 to 30 moose.

At present, few moose are harvested from the area above the Notigi control structure and flooding is not anticipated to have a serious effect on resident hunting patterns. However, moose harvests along the Burntwood River, in particular at Wuskwatim Lake, are expected to be seriously affected by a structure at Wuskwatim.

Increased access into the area is leading to an increase in sport hunting. Much of the area is now accessible by the recently completed Provincial Road 391 from Thompson to Leaf Rapids. This will lead to increased moose hunting in the Rat Lake area and the upper part of the Diversion Route. Increased sport hunting may conflict with subsistence hunting by Nelson House residents. Some harassment of ungulates will occur with increased access to the area, but should not be of major concern.

All the currently attractive waterfowl nesting areas and many of the staging sites along the Rat and Burntwood rivers will be lost with flooding. The effect on availability of waterfowl will be detrimental.

Effect on Trapping - The Notigi reservoir will flood productive furbearer habitat. There will be a downstream effect from Notigi even if no other sites are developed. Traplines along the Diversion Route will be affected to varying degrees by flooding. Within each trapping block the area to be flooded ranges from one to 50 percent (Table 7-4). As the area affected will be mostly productive shoreline, there will be a corresponding loss of potential fur production. The actual effect may be greater or less than the percent of land area lost. Shoreline and marsh areas contribute significantly more to furbearer production and are trapped more intensively than upland areas. Some affected shorelines may not have been trapped or trappable for reasons of remoteness. Inland creeks and ponds connecting with the system will also be affected. Suitable habitat will be reduced in all traplines. However, many will still retain areas of good potential furbearer habitat.

Forty registered traplines will be directly affected by flooding; thirty of these are in the Nelson House section. The traplines that will lose the greatest amounts of potential for fur harvest will be certain lines in the Nelson House and Southern Indian Lake sections. It should be noted that there has been little production over the past five years from some lines.

Shoreline habitat along the Burntwood River will be lost. The effect on furbearers will be similar to those predicted for upstream sites.

TABLE 7-4
AVERAGE ANNUAL FUR HARVEST VALUES* AND PERCENT OF LAND AREA AFFECTED IN REGISTERED TRAPPING BLOCKS ALONG THE DIVERSION ROUTE

| Registered Trapping Block Number | Average Annual Returns for 1967/68-1971/72 *** | Percent of Registered Trapping Block Flooded**** | Percent of Registered Trapping Block Area Actively Trapped Anticipated to be Flooded* |
|---|---|---|---|
| NELSON HOUSE SECTION | | | |
| 2/3 | 433 (4) | 7** | |
| 4 | 1,397 | 11** | 40 |
| 5 | 711 (4) | 50** | 50 |
| 8 | 720 (2) | ++ | |
| 9 | 829 | 1** | |
| 12 | 3,760 | 1 | |
| 18 | 1,154 (4) | 1 | |
| 26 | 1,698 (4) | 15 | 70 |
| 27 | 1,045 (4) | 22 | 50 |
| 28 | 1,970 | 7 | 40 |
| 29 | 711 | 14 | |
| 30 | 2,422 | 3 | |
| 31 | 1,004 | 5 | |
| 32 | 1,505 (3) | ++++ | |
| 33 | 3,930 | 1 | |
| 34/35 | 1,946 | 15 | 30 |
| 36 | 1,906 | 30 | |
| 37 | 1,283 | 35 | 10 |
| 38 | 1,224 | 15 | |
| 39 | 5,502 | 4** | 10 |
| 40 | 1,828 | 3** | 5 |
| 41 | 479 (4) | 1** | |
| 42 | 682 (4) | 2** | 5 |
| 47 | 1,325 | 20** | 1 |
| 49+++ | 3,645 | 9** | 25 |
| 53A | 137 (3) | 20** | |
| 53B | 13 (1) | ++ | |
| 60 | 2,680 (4) | 13** | |
| SOUTHERN INDIAN LAKE SECTION | | | |
| 3 | 1,390 (4) | 15 | |
| 4 | 3,527 | 27 | |
| SPLIT LAKE SECTION++ | | | |
| 11 | 1,750 | | |
| 12 | 1,779 | | |
| 70 | 1,738 (4) | | |
| THICKET PORTAGE SECTION++ | | | |
| 32 | 795 (3) | | |
| PIKWITONEI SECTION++ | | | |
| 44 | 1,151 | | |
| 57 | 5,153 | | |
| 60 | 1,028 | | |
| 67 | 837 (2) | | |

* *Calculated for the 5-year period 1967/68 to 1971/72 except where values were calculated from number of years shown in brackets.*

** *Indicates flooding from proposed Wuskwatim and Manasan structures.*

*** *Based on fur dealer returns and average Winnipeg prices.*

**** *Approximate land area which will be flooded in each Registered Trapping Block (based on area calculations). from Notigi, Wuskwatim and Manasan structures.*

+ *Areas actively trapped are based on interviewers with trappers. Percent to be flooded is approximate only , from Notigi (850 ft), Wuskwatim (800 ft) and Manasan (690 ft) flood lines.*

++ *No area calculations done as flood line information for First Rapids not available.*

+++ *Community Line.*

++++ *Under maximum Notigi flooding only.*

## FOREST RESOURCES AND FORESTRY

A forest resources inventory of the area to be inundated due to the diversion project was conducted by the Forest Inventory Section, Manitoba Department of Mines, Resources and Environmental Management. Above the Notigi control structure, the inventory covered all lands up to the 850 ft elevation contour. Below Notigi, the inventory identified the area to be lost due to diversion and the additional area that would be lost as a result of construction and operation of the proposed generating stations at Wuskwatim and Manasan.

FOREST RESOURCES - The Diversion Route area lies within the northern coniferous zone. Typical black spruce forest prevails on the glacial and alluvial soils. Dedicuous growth is limited to areas of regeneration and near watercourses. As indicated above, the construction and operation of diversion works to divert some of the flow from the Churchill River, will cause a loss of forest resources along the Diversion Route. Additional forest resources will be lost when the proposed hydroelectric plants are constructed at Wuskwatim and Manasan.

### EFFECT ON FOREST RESOURCES

Effect Above Notigi - There will be significant forest loss from flooding in the area between South Bay on Southern Indian Lake and the Notigi control structure. This area has been contour mapped and the 850 ft elevation contour has been designated as the boundary of inundation with diversion. Based on this boundary, 101,484 acres of existing land surface will be inundated. Non-productive forest covers 44,376 acres, 8154 acres have no forest cover and 48,954 acres are timber covered. Softwoods cover 33,779 acres and hardwoods cover 15,175 acres.

It is estimated that this area contains 16,935,000 cubic feet of gross merchantable softwood and 12,530,000 cubic feet of gross merchantable hardwood. Gross merchantable is a volume measure of all tree species with diameters of 3.6 inches and larger, measured 4.5 ft above ground level. The net operable volume, or the volume of an area which has over 800 cubic feet of timber per acre minus expected and known losses in volume due to decay, damage and distribution of stands, that will be lost is 2,189,000 cubic feet of jack pine, black spruce, white spruce and balsam fir.

The timber clearing program implemented by Manitoba Hydro when completed will result in the removal of timber from approximately 26,600 acres of the 101,484 acres of land that are anticipated to be flooded. Vegetative cover will be cut, piled and burned on approximately 20 percent of the area designated for clearing. The remainder will be cut and left.

Effect Below Notigi - The area between Notigi control structure and Manasan Falls was contour mapped and the maximum open-water elevation designated as the boundary of inundation with the diversion project. Based on this boundary, 43,801 acres of existing land surface will be inundated along the Diversion Route between Notigi and Manasan Falls. Non-productive forest covers 14,678 acres, 4,930 acres have no forest cover, and 24,193 are timber covered.

It is estimated that this area contains 14,771,000 cubic feet of gross merchantable hardwoods and softwoods. The net operable volume that will be lost is 1,968,000 cubic feet.

Effect of the Proposed Wuskwatim Generating Station - The area that will be flooded and the loss of forest resources are dependent on the forebay elevation that will be selected for the Wuskwatim generating station. Forest resource losses were calculated based on forebay elevations of 800 ft and 810 ft for Wuskwatim. With a forebay elevation of 800 ft, an additional 19,886 acres of existing land surface will be inundated between Notigi and the Wuskwatim generating site. The net operable volume loss will be 163,000 cubic feet in addition to the 1,941,000 cubic feet lost due to the diversion project.

If the Wuskwatim forebay is designated at 810 ft, 40,449 acres of existing land surface will be inundated between the Notigi control structure and the Wuskwatim generating station. This is in addition to the 39,771 acres that will be inundated due to the diversion project. The net operable volume loss is an additional 2,242,000 cubic feet.

Effect of the Proposed Manasan Generating Station - As with the construction and operation of Wuskwatim generating station, the area inundated and the loss of forest resources associated with the Manasan generating station is dependent on forebay elevation selected. Forest resource losses were calculated based on forebay elevations of 690 ft and 700 ft for Manasan. At elevation 690 ft, 27,903 acres of existing land surface will be inundated along the Diversion Route between the proposed Wuskwatim and Manasan generating stations. This is in addition to the 4030 acres that will be flooded along this section due to the diversion project.

The net operable volume loss will be 577,000 cubic feet more than that lost due to the diversion project.

Assuming the forebay elevation is 700 ft, 37,845 acres of existing land surface will be inundated between Wuskwatim and Manasan. This figure does not include the 4030 acres that will be flooded due to the diversion project. The net operable volume loss at elevation 700 ft is 836,000 cubic feet in addition to the amount lost due to the diversion project.

FORESTRY - The area to be flooded by the diversion project lies within the specified area of Manitoba Forestry Resources Ltd. The majority of the land anticipated to be flooded is provincial Crown land but some private land and Indian reserve land will be flooded at Nelson House. The area of Indian reserve land to be flooded has been estimated to be less than 2000 acres.

Forestry operations in the area are limited to the provision of building materials and fuel for residents of local communities. The licence to cut merchantable timber is held by Manitoba Forestry Resources Ltd., a Crown Corporation. As of April, 1974, there were no operations to harvest the resource. The forestry production potential of merchantable timber along the Rat-Burntwood Diversion Route could total 1,700,000 to 2,500,000 cubic feet per year in the short term and up to 6,500,000 cubic feet per year, 10 to 20 years hence. The basic problem is the distance required to transport the timber to the forestry complex at The Pas and the absence of feeder roads off Provincial Road 391 north and south to provide access to the harvestable forest stands. Establishment of any large-scale forestry operation in the area would depend upon future demand for forest products and the establishment of adequate facilities for removal.

EFFECT ON FORESTRY - Implications of diversion for the present forestry operations in the Rat-Burntwood rivers area are negligible. However, if future demand requires harvesting of the merchantable timber, certain factors relating to diversion would have to be considered. The Notigi forebay could provide the means of transporting cut timber from South Bay to Notigi. The timber could be collected near the Notigi dam site and trucked via Provincial Road 391 either to The Pas, or to Lynn Lake for furtherance to The Pas by rail. The economics of the venture (amount of merchantable timber versus removal costs) and access to the resource would have to be considered for any proposed operation. The Wuskwatim and Manasan forebays could also be used to transport cut timber for collection near the Wuskwatim and Manasan generating stations. The operations would be dependent upon economics, accessibility, and whether access roads from Provincial Road 391 to the construction sites at Wuskwatim, Manasan and First Rapids could be effectively utilized for timber operations.

## MINERAL RESOURCES AND MINING

MINERAL RESOURCES - Mineral development in the Rat-Burntwood diversion route area has been limited to a few areas, of which the major centre of activity is Thompson. Commercial nickel production by the International Nickel Company of Canada Limited began in 1961. Nickel ore is presently mined at Thompson, Birchtree and Pipe No. 2 mines. These mines should continue to be in production in the future. In addition to these mines the company has developed the Soab North, Soab South and Pipe No. 1 mines which remained closed during 1974, and are being maintained on a stand-by basis.

Mystery Lake is located about 10 miles to the northeast of Thompson in the Moak Lake-Setting Lake nickel belt. Nickel mineralization under the southwestern end of Mystery Lake forms potentially the most attractive deposit for future development. The deposit is of large tonnage-low grade type (200 million tons at 0.45 percent nickel) and if developed would probably be an open pit operation. However, prevailing market conditions for the nickel will probably deter exploitation of the Mystery Lake nickel deposit in the near future.

EFFECT ON MINERAL RESOURCES - A study was carried out by the Geological Surveys, Mines Branch, Manitoba Department of Mines, Resources and Environmental Management, of the geology of the eastern section of Ospwagan Lake. The area is located between nickel-producing mines and contains igneous and sedimentary formations which are known to contain nickel. It has been extensively explored in the past by various mining companies. Geological maps have been prepared based on the geological survey of the exposed bedrock formations which will be flooded by the diversion.

Known mineralization is limited to outcrops bordering the ultramafic bodies which underlie Ospwagan Lake. The areas of known nickel mineralization around Ospwagan Lake are held under mining leases by the International Nickel Company of Canada Limited. Flooding in the area should not hinder any future mineral development.

MINING ACTIVITY - In the Diversion Route area, mining operations over the past 20 years have become the most important resource industry in terms of employment and production. Discovery of nickel in the vicinity of what is now the City of Thompson by The International Nickel Company of Canada Limited in 1956 resulted in the creation of a major mining, smelting and refining industrial complex and the largest population centre in northern Manitoba.

EFFECT ON MINING ACTIVITY - With regard to the implications of diversion on the mining and processing operations, it is not expected that the facilities will be adversely affected. The mining operations near Thompson are situated at various sites to the south and east of the city, but do not impinge on that portion of land which will be inundated by the diversion of flows from the Churchill River. Also the forebay that will be created by the Manasan generating station will not flood any of these sites. Therefore, these operations will not be affected by the diversion project.

Processed nickel slabs are shipped south to markets by rail via the Hudson Bay line of the Canadian National Railways and by truck via Provincial Road 391 and Provincial Trunk Highway 6. The alignment of this branch line as it enters Thompson is such that its closest proximity to the Burntwood River is approximately one-half mile. It is not expected that the railway line will therefore suffer any adverse effect as a result of the diversion project. In addition, Provincial Road 391 at Thompson will not be affected by the diversion project. Therefore, it is anticipated that transportation of mineral resources will not be affected by diversion.

## OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION

OUTDOOR RECREATION RESOURCES - In order to assess the effect of the diversion project on recreation, Parks Branch, Manitoba Department of Tourism, Recreation and Cultural Affairs, prepared two inventories of recreation opportunities and potential. The first inventory was based on the existing state, i.e., prior to implementation of diversion. The second took into consideration the effect of the diversion project. The inventories were then compared to determine the loss or gain to recreation resources due to the diversion project.

Prior to the implementation of the diversion project, the Diversion Route had great potential as an area for wilderness canoeing, camping, hunting, fishing and photography. The area was suitable for family vacationing, specifically at points along Provincial Road 391 which provides access to the Footprint River near Nelson House, to the Rat River at Notigi and to the Suwanee River.

EFFECT ON OUTDOOR RECREATION RESOURCES - There are 850 square miles of usable water area within 20 miles from Provincial Road 391 on either side. Of the water area, 255 square miles or 30 percent will be affected by diversion of the Churchill River. This water area will be lost to intensive recreation use due to flooded standing timber, floating and submerged debris and general aesthetic degradation. The thousands of acres of uncleared flooded shoreline will destroy the aesthetic appeal of the route. Dead standing timber, submerged deadheads, floating debris and inundation of beaches and rock outcrops will make shoreline access very difficult.

Rat Lake, one of the most beautiful lakes along the Diversion Route, has potential for outdoor recreation. It will be inundated by 30 ft of water as its level rises from approximately 817 ft to 847 ft. This will destroy its potential for commercial hunting and fishing lodge sites and its wilderness potential for canoeing, photography and nature study.

A wayside park development at the Suwanee River crossing at Provincial Road 391 would still make Rat Lake accessible by canoe, and the lake could still be put to extensive use for sport fishing as northern pike production could increase by as much as 100 percent. The wayside campground could be designed to provide twenty-five to thirty sites initially, with room for expansion as demand grows. Facilities required would be barbecue pits, tables, boat launch ramp, dock, sanitary facilities and water. This facility could be established and operated by the Parks Branch, Manitoba Department of Tourism, Recreation and Cultural Affairs, or by a commercial operator who would also operate a gas station and restaurant complex and a rental cabin service.

The road crossing at the Notigi dam site will become a stopping point for people travelling along Provincial Road 391. The control structure, generating station and reservoir will be a tourist attraction and this will make provision of suitable facilities highly desirable. It is anticipated that a picnic site, boat launch and camping facilities will be required to serve transient visitors. A boat launch in the vicinity of the dam would provide access to the entire reservoir area. A picnic site near the main dam would be an asset to those persons using the area for interpretative purposes and for those fishing in the vicinity of the control structure.

Near the main dam, powerhouse and spillway, a viewpoint picnic area could be provided consisting of an elevated platform to provide a good view of the project with explanatory diagrams and possibly a taped descriptive presentation. A small picnic area of five to ten sites should also be provided. Access to the spillway would be desirable for fishing. Facilities needed would be the tower and interpretative material, picnic tables, firepits, sanitary facilities, fish cleaning pits and water.

A boat launch could be provided on a bay below the dam to provide access to Wapisu Lake. However, the diversion flows will raise the level of Wapisu Lake negating most of its scenic wilderness potential, and flood beach and outcrop areas suitable for camping.

The natural, aesthetically pleasing, setting of Footprint Lake will be greatly reduced if not totally destroyed with increases in water level. Raised water levels will result in dead vegetation around the water's edge and bank slumpage which could take as long as 30 years to stabilize. Such aesthetic degradation would cause a marked reduction in the quality of life for Nelson House residents.

Present rock shelves around the settlement and a sand beach opposite the settlement now provide much of the summer recreation base for children and other residents at Nelson House. A rise in water levels would cover the rock shelves and beach, leaving an undesirable mudflat. This will create a void in the present life style of the residents of Nelson House.

Aesthetic degradation would remove the present potential which the Footprint Lake area holds for establishment of a locally initiated, owned and operated tourist development consisting of a living history museum. Such a venture, if properly planned with respect to social conditions, could result in not only a local industry, but could also be a deciding factor in preserving cultural history and serve to reinforce the personal pride of the Nelson House Cree and Metis in their culture.

The rise in water levels on Threepoint and Footprint lakes will negate many of the attractions required for a commercial lodge operation and a living history museum at Nelson House. The rock footprints will be covered; beach area and shoreline flooded, reducing the scenic value; and the trading post location on Threepoint Lake flooded, making reconstruction on its original site impossible. A motor launch tour would be eliminated since most of the attractions would be under water. A museum and handicraft factory are still possible but it is doubtful if they would provide a large enough attraction to draw people from the road.

Increased velocities with diversion will have little effect on use of the Burntwood River for waterskiing in the vicinity of Thompson. Higher water levels at the first set of rapids below Thompson will probably submerge them, eliminating their scenic value and use of the area as a boat-in picnic site.

The proposed power development project to be located immediately below Wuskwatim Lake will raise the lake level from 760 to 810 ft. The shoreline is mainly on low bedrock and will be extensively flooded. The falls at Wuskwatim and Taskinigup will be eliminated. It is also expected that a Cree dancing circle, a religious ceremonial site located along the portage south of the lake, will be destroyed by flooding. However, it may be possible to preserve this site by protective dyking.

Manasan Falls is a possible site for a provincial heritage park, and viewing points and a boat-in picnic area could be developed. However, the diversion project will reduce the vertical fall and if the Manasan Falls generating station is constructed as proposed, it will eliminate this scenic area and the recreation potential associated with the site.

The proposed First Rapids power development will cause the level of the river to rise. Raised water levels due to the increased flow and the lake formed by the First Rapids generating station will cause raised water levels on Mystery Lake. The high bedrock shoreline should not be greatly affected, although low-lying beach areas presently used for camping and fishing will be inundated. However, the lake should still be suitable for fishing and some camping.

USE OF OUTDOOR RECREATION RESOURCES - The Diversion Route area is not lacking in recreation capability, but it is too far removed from current travel patterns and urban centres to be used intensively. In the future, the area may be used for extensive recreation such as commercial resorts for hunting and fishing, possible wilderness camping, fishing excursions or weekend fishing and sight-seeing trips. The prime recreation orientation will be directed to water use for powerboating and sport fishing.

The demand for outdoor recreation activities is growing in northern Manitoba at about 5 percent annually. A recent survey of Thompson residents indicated that a large portion of the population was not active in outdoor recreation. Of the active residents, the majority participated only during the summer because of the severity of the winter and the cost of winter participation, e.g., cost of power toboggans.

The activities undertaken lend themselves to the northern environment. In order of importance, they were: picnicking, fishing, swimming, camping, boating, cottaging. Cottaging is the least important due to high construction costs and high mobility of northern residents which reduces the likelihood of large capital investments in permanent building structures.

Most activities are presently carried out at Paint Lake or on the Burntwood River. Paint Lake, however, is becoming crowded and people are looking for new areas. With the completion of Provincial Road 391 from Thompson to Lynn Lake, a vast new area has become available for people dissatisfied with the facilities at the Paint Lake Provincial Recreation Area. The new road passes numerous lakes which are available for boating and fishing, while the river crossing areas provide access to the entire Rat and Burntwood rivers' drainage area.

The Burntwood River above Thompson is used extensively for water skiing, and a small local campground and picnic area are being developed on the banks. Below Thompson, the river is used for powerboating, and Mystery Lake is used for fishing and limited camping. The first set of rapids downstream from Thompson could also be developed as a small picnic site.

Completion of Provincial Road 391 from Thompson to Leaf Rapids and the connecting road to Nelson House will have a profound effect on the use of recreation resources in the area. This will occur because access by road is more economical than is available through the use of charter or scheduled air flights. The recreation and natural resources will be made available to motorists and for family vacations rather than be limited to those who can afford expensive charter flights.

While the new highway crosses at only one point on the Rat River, it crosses many tributaries of the Rat River along its route thus making the area accessible by boat. Many of these crossings are outside the limits of the Diversion Route area, but are nevertheless important for their regional recreation significance. The crossing areas make not only those lakes immediately adjacent to them accessible, but the entire river system and connecting tributaries and lakes will be opened for wilderness camping and canoeing.

Vacation traffic is not expected to be heavy and most trips will be made by residents of Thompson, Leaf Rapids and Lynn Lake. Estimated vacation traffic of 100 vehicles per day over a 96 day summer season would mean 35,000 vacationers using the new highway by 1980. An estimated 48,000 local northern residents would also annually use the highway.

EFFECT ON THE USE OF OUTDOOR RECREATION RESOURCES - The diversion project has probably stimulated interest in travel to northern Manitoba. Use of the Diversion Route for outdoor recreation could be encouraged following implementation of the diversion project by installing facilities for visitors and sportsmen at Notigi and by removing debris from Notigi forebay area.

## ARCHAEOLOGICAL RESOURCES

The Churchill Diversion Archaeological Project group intensively surveyed the five large lakes on the Rat-Burntwood rivers: Notigi, Wapisu, Threepoint, Wuskwatim and Opegano Lakes. Approximately 40 percent of the shoreline was surveyed. Thirty-two archaeological sites were identified and excavated, and twenty random finds were recorded (Fig. 7-5). The random finds represent isolated artifacts on the surface of beaches. The sites ranged from beaches with a few shreds and stone tools to large seasonally occupied sites containing a great number of sub-surface features and artifacts.

Over 10,000 items of natural cultural remains were recorded during the surveys and excavations. Over one-half of these items were recovered from the extensive excavations at two sites and included projectile points, stone scrapers, pottery and European trade beads and tobacco pipes.

The information collected during this archaeological survey produced new and significant data on early penetration into the area. Recorded sites ranged from possible Early Man (6000 B.C. to 2000 B.C.) to early historic sites and perhaps a Northwest Company trading post.

The quantity and the significance of the cultural debris collected during the survey surpassed the results of previous years. As noted, forty projectile points were collected during the survey while fifteen were collected during the 1969-71 survey of Southern Indian Lake. Very few prehistoric or historic sub-surface fire-pits were identified in other surveys in the area while many of these features were mapped and excavated during the present survey. Often these features contained several classes of artifacts. Features at some sites contained native pottery, arrowheads, European trade beads and trade pipes. These represent early historic sites indicating that the native population had not lost its indigenous ceramic and lithic tool traditions in the early stages of European contact.

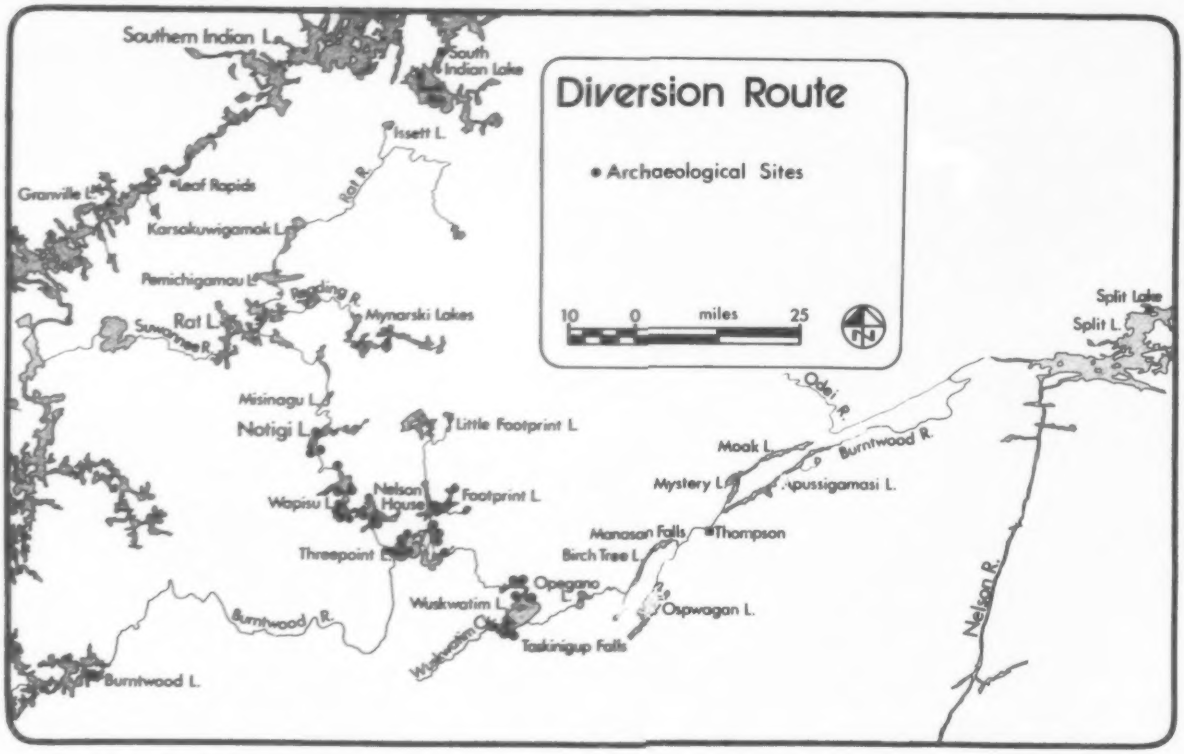

Diversion Route
• Archaeological Sites
10 0 miles 25
Southern Indian L.
South Indian Lake
Issett L.
Rat R.
Granville L.
Leaf Rapids
Karsakuwigamak L.
Pemichigamau L.
Reading R.
Mynarski Lakes
Rat L.
Suwannee R.
Misinagu L.
Notigi L.
Little Footprint L.
Wapisu L.
Nelson House
Footprint L.
Threepoint L.
Burntwood R.
Wuskwatim L.
Opegano L.
Taskinigup Falls
Birch Tree L.
Manasan Falls
Thompson
Ospwagan L.
Mystery L.
Moak L.
Apussigamasi L.
Burntwood R.
Odei R.
Split Lake
Split L.
Nelson R.
Burntwood L.

Fig. 7-5. Location of Archaeological Sites Identified During the 1972 Survey.

One very interesting site located at Threepoint Lake, is a native Cree dancing circle at Threepoint Lake which was used as a religious ceremonial site (Fig.7-6). Another site on the southwest point of Threepoint Lake (UNR 4), is believed to be an early European winter trading post. One section of the site contained metal tools and beehive shaped stone ovens. It is believed to be the site of a North-West Company trading post which is referred to as the Rat River Fort in the journal (1789-90) of the explorer and trader, McGillivray. These types of sites can yield valuable information on the early historic period and also have potential for recreation development.

Previous archaeological information had suggested that the major movement of population into the area occurred during the Terminal Woodland Period or roughly after 1000 A.D. However, two island sites produced two projectile point fragments of a type assigned very early dates in southern regions and may indicate penetration of a population into the area during what is referred to as the Early Man Period (6000 B.C. to 2000 B.C.). However, on the basis of only a small lithic tool sample, it is difficult to date these sites since they are small and many of the lithic tool classes are non-diagnostic. Site UNR 50 and firepits discovered in the lower

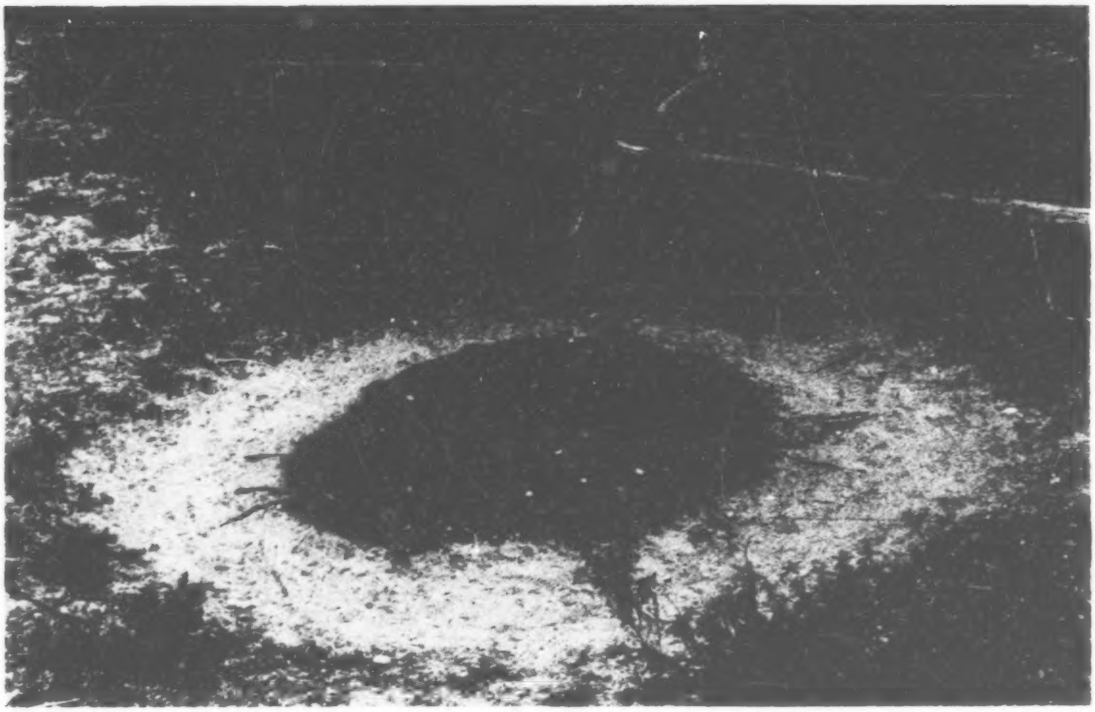


Fig. 7-6. Photograph of a Native Cree Dancing Circle, Threepoint Lake, 1972.

levels of UNR 23 are thought to be representative of the period 2000 B.C. to 600 B.C. Six sites were excavated which contained pottery assignable to the period 600 B.C. to 800 A.D. (Initial Woodland Period), and sixteen sites contained pottery dating from 1000 A.D. to 1690 A.D. (Late Prehistoric Period).

Two of the six sites produced many sub-surface features and good pottery and lithic samples. These are the two most northern Initial Woodland sites recorded in Manitoba. The sixteen sites are assigned to the Clearwater Lake Phase of the Terminal Woodland Period. Several archaeologists attribute this phase to the Cree speaking people. The archaeological evidence, supplemented by early historic accounts, suggests a complex migratory subsistence pattern of the Native Cree who exploited far-flung gathering and hunting grounds on a regular seasonal basis.

For the most part, sites were small, the majority representing transient camp sites or wind stops. Several of the small sites have sub-surface firepits suggesting cooking activities as well as artifacts indicating hunting and hide processing activities. Other sites appear to be larger suggesting seasonal habitation. The bone preservation of one particular site was good and when identified should yield information on the seasonal occupation of the site and diet of the people.

EFFECT ON ARCHAEOLOGICAL RESOURCES: Effects of the diversion from the Churchill River on archaeological sites along the Rat and Burntwood rivers can be classified into three categories. The destruction of sites during the flooding, during the construction activities and due to the increase in the rate of erosion that will occur at the higher water levels and flows. Based on the field survey of the Rat and Burntwood rivers, it is estimated that 700 archaeological sites will be destroyed either directly by flooding or indirectly because of the increase in the rate of erosion of the shoreline on which these sites have been excavated. Specifically, two significant sites will be destoryed: sites UNR 23 and UNR 4. Site UNR 23, at which pottery estimated to be from the period 600 B.C. to 800 A.D. was found, is located in the vicinity of the Manitoba Hydro construction camp at Notigi. It is rapidly being destroyed because of the construction activities in the area. Site UNR 4 is the site believed to be the Rat River Fort. Part of this site will be flooded and the remainder will be subject to increased erosion.

As with the regulation of Lake Winnipeg, the diversion from the Churchill River has reduced the time available for archaeological research in the area to be affected but it has resulted in substantial funding for research over the past four years. Numerous sites on the Diversion Route have been excavated and substantial collections of artifacts have been recovered. Analysis of these artifacts has expanded knowledge of the habitation of these areas by prehistoric and historic cultures.

## TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES

This section provides an examination of the implications of the Churchill River diversion project and associated hydroelectric projects for existing and proposed transportation and navigation facilities and services in the Diversion Route area. An inventory of the physical transportation and navigation facilities and services is presented and the effect of the diversion and of future hydroelectric projects on these is examined. In addition, the effects of the diversion project on transportation services to, from and within the communities along the Diversion Route is evaluated.

EXISTING AND PROPOSED TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES - Transportation and navigation services and facilities of the Diversion Route area consist of six basic components: regional all-weather roads, intra-community roads, navigation routes, docks and wharves, airstrips, and float plane landing bases.

The area is served by one regional all-weather road. A portion of Provincial Road 391 connects the communities of Thompson, Nelson House (via a 6.4 mile access road), Leaf Rapids (a distance of 132 miles from Thompson) and Lynn Lake (a distance of 196 miles from Thompson) with the provincial highway network. This road opened in November, 1973. It provides all-weather access by vehicular traffic (private and commercial) to Leaf Rapids and Lynn Lake via Thompson. It is expected that the entire section of Provincial Road 391 from Thompson to Lynn Lake will gradually be upgraded to the status of a primary gravel road (alignment for speeds up to 70 miles per hour) as part of the Manitoba Department of Highways program of northern road construction.

Construction of a road from Thompson to Gillam is currently underway. Work has started on the first 40 miles of an all-weather pioneer road. Under the Canada (Department of Regional Economic Expansion) - Manitoba (Department of Northern Affairs) Interim Subsidiary Agreement on the Manitoba Northlands, provision is made for highway preengineering and design, and studies for the purpose of locating and designing extensions of the existing highway system in northern Manitoba, including construction of the road from Thompson to Gillam. In November, 1974, tenders were called for grading a pilot road from mile 17 to mile 39 of the Thompson-Gillam road. This project starts at approximately Moak Lake in Township 80, Range 1 West and proceeds northeast to a point in Township 81, Range 3 East for a distance of approximately 22 miles. Work on the road between Thompson and Gillam will be continued under an extension to the above mentioned agreement.

Thompson has an extensive paved road system, most of which is at an elevation of 675 ft or higher. No portion of this road system lies on the north shore of the Burntwood River except for Provincial Road 391 and its airport extension.

Most of the dwellings at Nelson House are situated near Footprint Lake except for a portion of the southwest section of the community. The main road follows the basic configuration of the shoreline. There are branches to several areas in the community. Nelson House is linked to Provincial Road 391 by a 6.4 mile access road built for the most part at an elevation of 820 ft or higher.

Navigation, apart from small motor boats and canoes, is confined to the major lakes along the Rat and Burntwood rivers and is associated primarily with the commercial fishery. Karsakuwigamak, Pemichigamau, Rat and Mynarski lakes have been fished by members of South Indian Lake Co-op Fisheries Ltd. Navigation in terms of the fishery is internal to each lake except for movement from one lake to another. Other lakes including Notigi, Wapisu, Threepoint, Footprint and Wuskwatim are occasionally fished by residents of Nelson House, either for export or internal (domestic) use. At present it is physically possible to navigate the entire Rat and Burntwood rivers system from Issett Lake to Thompson and beyond by canoe or small motor boat.

Docks and wharves in the area are located at fish camps and at Nelson House and Thompson. Docking facilities at fish camps consist of a 13 ft wide dock on Rat Lake at an elevation of approximately 821 ft; a 20 ft wide dock on Wapisu Lake; and a 10 ft wide dock on Wuskwatim Lake. There are several minor docks at Nelson House as well as a longer dock (located in the southern portion of the community opposite the nursing station). These facilities are at an elevation of approximately 800 ft or lower. The major dock facilities at Thompson are associated with the float plane bases on the north shore of the Burntwood River east of the bridge. Much of this area is below elevation 620 ft.

Airstrips are in operation at Nelson House and Thompson. The airstrip at Nelson House is located in the northeast corner of the community at the junction of the community road and the access road to Provincial Road 391. The facility, owned by the government of Manitoba, has a runway length of 3000 ft which is at an elevation of 825 ft or higher. The airport at Thompson is one of the major air facilities in northern Manitoba, and is operable day and night. It is operated by the Local Government District of Mystery Lake and is located 5 miles by road north of the city. The major portion of the runway length of 5400 ft is at an elevation of 705 ft or higher. However, small sections of both ends (southwest and northeast) of the runway are below 700 ft.

Nelson House and Thompson are also served by floatplane landing bases. The base at Nelson House is situated on Footprint Lake immediately adjacent to the southern portion of the community. It is jointly operated by Ilford-Riverton Airways Ltd. and Lambair Limited from the last week in May to the last week in October. The dock serving incoming aircraft is the one situated in front of the nursing station. While operating conditions are good, caution is required as a result of reefs in certain areas of Footprint Lake. The floatplane base at

Thompson is located on the Burntwood River, 1000 ft downstream of the Provincial Road 391 bridge. It comprises three separate facilities, Ilford-Riverton Airways Ltd., Lambair Limited and Manitoba Government Air Division. The base is in operation from the last week in May to the last week in October. Caution is required during landing due to the fast water, especially near the highway bridge.

EFFECT ON TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES - The reservoirs which will result from construction and operation of the control structure at Notigi and of the power developments at Wuskwatim and Manasan will cause substantial flooding. Sections of the Thompson-Lynn Lake road (Provincial Road 391) which could be susceptible to flooding by these reservoirs are: Footprint River to Notigi, Nelson House access road and immediately north of Thompson. Possible damage due to flooding on these sections of the road would arise from bank instability, erosion and submergence.

With regard to the Footprint River-Notigi section, the Manitoba Department of Highways has indicated that Manitoba Hydro is financing additional works in the vicinity of the Notigi site such as causeway construction and rock armament on the existing grade where high water could cause erosion. The main control dam at Notigi will be used as the Provincial Road 391 crossing of the Rat River.

The portion of road immediately north of Thompson which will be affected begins 4 miles from the city and is 4 miles in length. It is estimated that the forebay created by the proposed power development at Manasan will cause this portion to be flooded to a depth of as much as 40 ft. Dyking to protect this section of road does not appear to be feasible. Remedial action will consist of either a 10 mile re-routing of the affected portion of the road so as to place it beyond the flooded area or raising it to an elevation above the maximum water level.

Creation of a large lake (elevation 700 ft) as a result of construction of the proposed generating station at Manasan Falls could possibly result in a flooding problem at Thompson. However, the lake is to be contained by dykes built to the 700 to 710 ft elevation and no flooding of the community is foreseen. Some flooding of the Burntwood River in Thompson will be caused by creation of a reservoir (elevation 610 ft) in connection with the proposed First Rapids generating station.

Construction of a generating station at Wuskwatim will raise the level of Footprint Lake and will seriously affect the internal community road network. Sections of the community road in three areas will likely be flooded. These include: a 600 foot section midpoint at approximately latitude 55°47'40"N and longitude 98°53'20"W (flooding in this area will isolate the southern portion of the community from the mainland); an 800 foot section midpoint at approximately latitude 55°47'45"N and longitude 98°52'10"W; an 1800 foot section midpoint at approximately longitude 98°51'10"W. The Nelson House access road, connecting the community with Provincial Road 391, will experience a certain amount of flooding. The three sections so affected are: a 1200 foot section midpoint at approximately latitude 55°49'25"N and longitude 98°51'30"W; an 800 foot section midpoint at approximately latitude 55°49'55"N and longitude 98°51'25"W; a 200 foot section midpoint at approximately latitude 55°50'05"N and longitude 98°51'25"W.

Construction of control structures and generating stations at Notigi, Wuskwatim, Manasan and First Rapids will create forebays far above the present level of the lakes and rivers along the Diversion Route. In effect, a large lake will be formed upstream of each of these sites. Creation of the forebays will result in submergence of a certain amount of the present lake shorelines. Since the clearing programs will probably consist mainly of cutting trees but not cutting and burning, much of the debris will remain in the lakes for many years. The effect of the flooding of shorelines on internal lake navigation, especially on lakes involved in the commercial fishery, could be quite significant. The sections of shoreline which will be cut but not burned will become difficult landing areas, due to large amounts of floating debris. This situation will prevail until a long range program of collecting debris has been completed. Moreover, large cut trees which may float out into the lakes could become navigation hazards, possibly causing damage to fishing vessels. Fishing nets could also become entangled in floating debris and damaged. Construction of the control structures will require lengthy portages at each site and thus will affect long distance navigation. Provision of a boat landing and launch facilities at each power development or control structure site would be highly desirable.

The docks at the fish camps on Rat,Wapisu and Wuskwatim lakes are all at elevations well below the maximum forebay elevations which will result from construction of the control structure at Notigi and the power development at Wuskwatim. New docks will therefore be required.

As noted, all dock facilities at Nelson House are at an elevation of 800 ft or lower. Since the new elevation of Footprint Lake when the Wuskwatim generating station is built will be approximately 806 to 810 ft under ice free conditions, the docking and landing facilities at Nelson House will be unusable. The level of the Burntwood River at Thompson (under the effect of the proposed First Rapids generating station and increased flows) will rise to the extent that a strip of land 400 ft wide along the north bank of the river, downstream of the bridge, will be inundated. This strip of land includes the docking facilities associated with the floatplane bases and these facilities will therefore be rendered unusable.

The airstrip at Nelson House, at an elevation of 825 ft or greater, will be unaffected by the higher level of Footprint Lake. However, a portion of the lakeshore directly adjacent to the end of the airstrip on the southeast will be inundated. This shore area is unstable and the rise in water levels could increase this instability and possibly cause slumping or erosion of the bank, resulting in a possible hazard to aircraft. While the runway at Thompson airport is, for most of its length, at an elevation above the maximum Manasan forebay level of 700 ft, the southwest end is between 690 to 700 ft in elevation and could be affected to a minor degree by flooding.

As a result of construction of the Wuskwatim power development, the water level on Footprint Lake will increase significantly. This rise in water level could remove the hazard to float equipped aircraft caused by reefs in certain areas of the lake which are presently near the surface but which will be considerably below the surface following diversion. However, low islands and/or rock outcrops which are new well above the surface of Footprint Lake will become fully or partially inundated with the rise in water levels and could result in the creation of new reefs, presenting a possible hazard to aircraft landing. According to Manitoba Hydro, surface velocity in Footprint Lake will increase from 0.5 feet per second (fps) prior to diversion to 1.5 fps following diversion. Both the Canada Ministry of Transport and air carriers are of the view that this velocity increase will not affect the Nelson House floatplane base.

At Thompson, diversion of flows from the Churchill River into the Rat and Burntwood rivers system will result, at times, in an increase in flow of approximately 30,000 cfs above the present 10 year mean value of 3500 cfs and in a velocity of flow increase from 1.0 to 2.5 fps. The increased flow will result in formation of eddies or turbulence in the area downstream of the bridge in the vicinity of the floatplane landing areas on the Burntwood River at Thompson, and could contribute to hazardous landing conditions due to the extension of high lateral forces on aircraft during landing. The increase in velocity of flow, however, is not expected to have any significant effect on floatplane operations. However, pilots of aircraft using the base may have to be more cautious in operating under the new flow conditions.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON COMMUNITIES

There are two permanent communities in the Diversion Route area: Nelson House and Thompson. The effect of the construction and operation of the works to divert flows from Churchill River on these communities was evaluated by Planning Branch, Manitoba Department of Mines, Resources and Environmental Management. The effect of the diversion project on the economy, the labour force, community infrastructure and the social system of Nelson House were identified and evaluated. In Thompson, the effect on the economy, labour force and social system is anticipated to be minor. However, the effect on community infrastructure is anticipated to be significant.

## NELSON HOUSE

The community of Nelson House is located on Footprint Lake, a part of the Footprint River basin which flows into Threepoint Lake on the Burntwood River system. The community is now connected by road to Thompson which is approximately 50 miles to the east. The population of Nelson House is 1260, 1200 of the residents are of Registered Indian status and they live in two areas, Poplar Point and Dog Point. The remainder are primarily non-Registered Indians who have recently moved to a new remote housing development located just off the reserve about 5 miles away from the main settlement of Nelson House. Unlike most northern communities, the houses are located in street patterns rather than scattered along the shoreline. The age structure of the population is very young with 53 percent of the population under the age of 16. At present the community has one governing body, an elected chief and council which relates to the Canada Department of Indian Affairs and Northern Development for administrative and financial support. The non-Registered portion of the population does not have elected representation but is provided with local services by the Manitoba Department of Northern Affairs.

THE ECONOMY - In 1972-73, the total income of the Nelson House community was approximately $1,280,000 and the average income per person in the labour force, excluding income to transient residents,was $3,750. Fishing provided $56,800 or 5 percent of community income; trapping $47,500 or 3.5 percent; hunting $34,200 or 2.5 percent; fuel wood $38,500 or 3 percent; hydro development $470,000 or 37 percent; service industries $30,000 or 2 percent, and government $602,200 or 47 percent. Government expenditures are subdivided into wages $244,200 or 19 percent and transfer payments $358,000 or 28 percent (Table 7-5). Two percent of community

Two percent of community income was received in the form of cash and 12 percent in the form of income in kind (Table 7-5). Fifty-eight percent was in the form of wages and salaries and 28 percent was in the form of government transfer payments.

Effect on Trapping - Trapping accounts for approximately 3.5 percent of community income. Of this, 1 percent is from the value of the fur and 2.5 percent from the value of the meat obtained from the trapline. Over the period 1967-68 to 1971-72, the average gross value of fur sold at the Winnipeg auctions was approximately $64,000 (Table 7-6). During this time there were on average 105 trappers employed on the Nelson House registered trapline section.

Generally, there has been a downward trend in dollar returns from the Nelson House section. A record of $107,000 was set in 1968-69 when beaver and lynx harvests were particularly high. There is some correlation between the number of active trappers and total annual returns. The number of active trappers fluctuates annually, but has shown a slight decline from 1967-68.

Thirty trapping blocks in the Nelson House registered trapline section will be partially affected by the diversion project (Fig. 7-7). The gross average return from these trapping blocks over the period 1967-68 to 1971-72 was approximately $43,000 or 66 percent of the gross average returns. An average of sixty-six trappers worked on traplines in these blocks over the period 1967-68 and 1971-72.

When the traplines are flooded, the trappers will be affected in a number of ways. Fewer animals may be available because of diminishing habitat. Those trappers to whom new trapping grounds are assigned will have to become familiar with new areas. It will take one to 2 years for a trapper to have as thorough a knowledge of his new trapping area. In addition, new trails will have to be blazed by those trappers who must relocate their traplines.

In meetings with the Manitoba Department of Mines, Resources and Environmental Management personnel, Nelson House trappers have agreed to reorganize trapping block boundaries so that the productive land available to each trapper is equalized. In this reorganization, a number of trappers whose lines are not directly affected by flooding will forfeit some of the land within their blocks to affected trappers. As a result of the reorganization, no trapper will be forced to discontinue trapping.

### TABLE 7-5
### PERCENTAGE COMMUNITY INCOME BY ACTIVITY AND TYPE, NELSON HOUSE, 1972-73

| | Income in Form of Cash | Income in Kind | Income in Form of Wages and Salaries | Government Transfer Payment | Total |
|---|---|---|---|---|---|
| Fishing | 1% | 4% | - | - | 5% |
| Trapping | 1 | 2.5 | - | - | 3.5 |
| Hunting | - | 2.5 | - | - | 2.5 |
| Fuel Wood | - | 3 | - | - | 3 |
| Hydro Development | - | - | 37% | - | 37 |
| Government: Permanent | - | - | 9 | 28% | 47 |
| Government: Temporary | - | - | 10 | | |
| Service Industries | - | - | 2 | - | 2 |
| TOTAL | 2% | 12% | 58% | 28% | 100% |

### TABLE 7-6
### NELSON HOUSE REGISTERED TRAPLINE SECTION FUR HARVEST RETURNS AND NUMBER OF ACTIVE TRAPPERS 1967-68 TO 1971-72

| Year | All Trapping Blocks | Partially Affected Trapping Blocks* | Percent Value Affected Trapping Blocks | Total Active Trappers | Active Affected Trappers | Percent Active Trappers Affected |
|---|---|---|---|---|---|---|
| 1967-68 | $ 63,249 | $ 31,673 | 50 | 113 | 63 | 56 |
| 1968-69 | 106,583 | 77,417 | 72 | 126 | 80 | 63 |
| 1969-70 | 58,880 | 41,369 | 70 | 112 | 77 | 69 |
| 1970-71 | 42,004 | 28,606 | 68 | 88 | 52 | 59 |
| 1971-72 | 49,264 | 36,187 | 73 | 88 | 59 | 67 |
| AVERAGE | 63,996 | 43,050 | 66 | 105 | 66 | 63 |

* *Those Registered trapping blocks partially affected by flooding along the Diversion Route. Degree of impact upon fur harvest returns will vary.*

*Source: Manitoba Department of Mines, Resources and Environmental Management, Fur Dealer Returns, The Pas, Manitoba.*

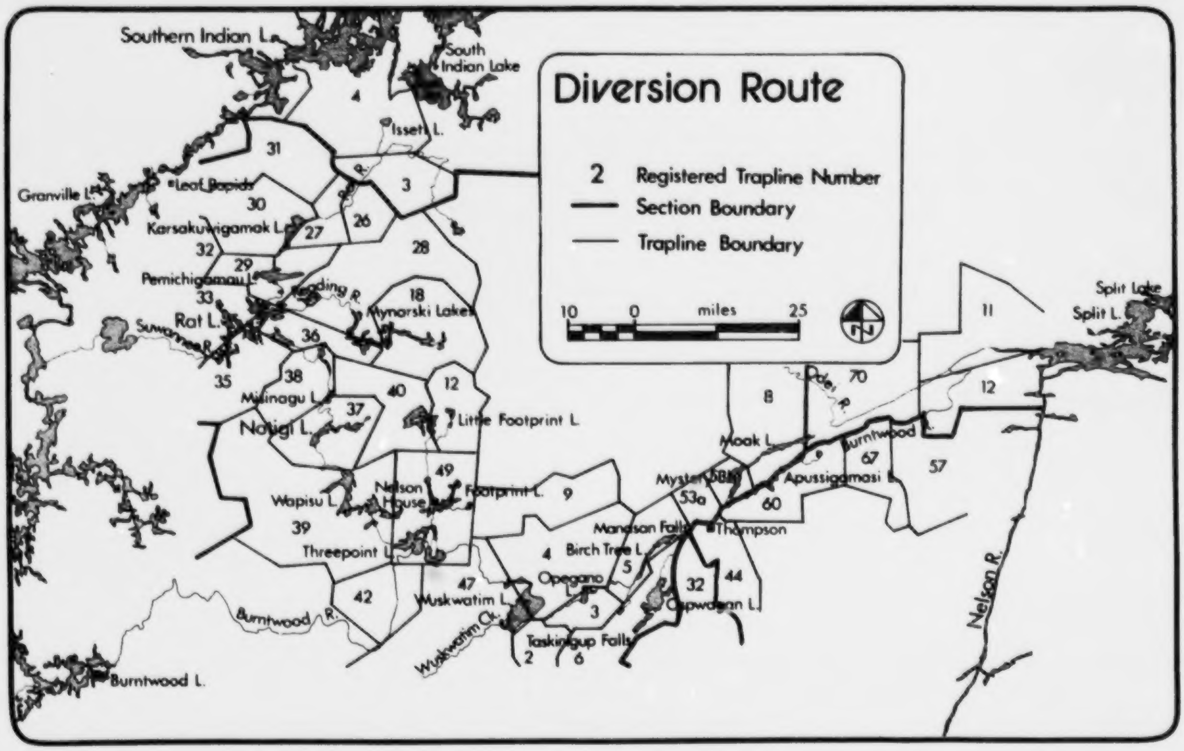

Diversion Route
2 Registered Trapline Number
Section Boundary
Trapline Boundary
10 0 miles 25
Southern Indian L.
South Indian Lake
Issett L.
Granville L.
Leaf Rapids
Karsakuwigamak L.
Pemichigamau L.
Rat L.
Wapisu L.
Nelson House
Threepoint L.
Little Footprint L.
Footprint L.
Wuskwatim L.
Birch Tree L.
Opegano
Taskinigup Falls
Manasan Falls
Thompson
Apussigamasi
Burntwood
Burntwood R.
Burntwood L.
Nelson R.
Split Lake
Split L.
Moak L.
Mystery L.
Notigi L.
Mynarski Lakes

Fig. 7-7. Nelson House Trapping Blocks Expected to be Affected by the Churchill River Diversion Project.

Those trappers who are relocated will have to devote a portion of their trapping time to searching for a new area and as a result will suffer a loss of income. Unless the trapper is compensated for this loss, he and his family will suffer undue hardship during that period. It is suggested that Manitoba Hydro and the trappers reach a mutual agreement regarding compensation for losses incurred.

The Rat and Burntwood rivers have been used by trappers for access to their traplines. Unstable ice conditions along these rivers will inhibit use of this traditional means of access. New access routes will have to be blazed on both sides of the Diversion Route and branches from main trails to individual traplines will be required.

Trapping provides a source of food as well as a source of cash. Meat from muskrats, beaver, lynx and rabbit is consumed by trappers and their families. This source of food will be reduced as a result of the diversion project.

Effect on Fisheries - In 1973, the commercial fishery provided approximately $7730 in net income to the thirty-three fishermen of Nelson House (Table 7-7). In addition, the fishery provided the equivalent to $46,100 in the form of income in kind to the community.

Those lakes which will be affected by the diversion project and which have been fished in the past five years include Wuskwatim, Rat, Mynarski and Wapisu lakes. Of these, Wuskwatim Lake is commercially viable and will be affected by the diversion. Net cash earnings from fishing the lake have been as high as $5000 for a summer season. However, there is insufficient data to assess the effect of the diversion project on earnings.

There is the possibility that the diversion project may result in improved fishing in areas that have not been fished in the past five years and where there could be a post-diversion increase in the fish population. However, floating and sunken debris will make it impossible to utilize gillnets for many years following diversion.

Losses resulting from the diversion project could possibly be offset by exploiting unaffected areas more fully. There are a number of lakes fished by Nelson House residents which will not be affected by the diversion. The combined quotas on these lakes have not been harvested in any of the past five years. Unless activities increase, the fishermen at Nelson House will continue to have a larger quota of fish available to them than they have harvested in the past five years.

The potential annual earnings by Nelson House fishermen from commercial fishing activities have been estimated to be $40,500 gross and $26,700 per year net. By comparison, average gross and net earnings over the past five years have been $16,990 and $10,060 respectively. This suggests that the potential earnings from commercial fishing are not presently fully exploited. However, if the full potential were achieved, commercial fishing is unlikely to be significant in terms of furture economic development.

Domestic fishing provides a greater benefit to the community than commercial fishing. A survey of Nelson House residents indicated that fish provided approx-11,500 household meals during the past year. Assuming $4 per household meal the value of this fish is $46,000. At present Footprint Lake is too shallow to be fished extensively, although nets are sometimes set at the narrows northeast of the community. Most fish for domestic comsumption is caught in the lakes at the headwaters of the Footprint River and in Wapisu and Wuskwatim lakes.

TABLE 7-7
GROSS AND NET INCOME OF NELSON HOUSE FISHERMEN, 1969-73

| YEAR | GROSS INCOME | NET INCOME | NUMBER OF FISHERMEN |
|---|---|---|---|
| 1969 | $23,850 | $12,580 | 35 |
| 1970 | 26,180 | 14,830 | 46 |
| 1971 | 7,750 | 4,470 | 13 |
| 1972 | 16,160 | 10,680 | 29 |
| 1973 | 11,000 | 7,730 | 33 |
| AVERAGE | 16,990 | 10,060 | 31 |

Effect on Hunting- Hunting provides the equivalent to approximately $34,200 in community income in the form of income in kind. This consists of meat from waterfowl, moose, grouse and ptarmigan. It is estimated that this activity provides 2.5 percent of the total community income. The annual moose harvest is 25 to 30 animals, with a potential harvest of several more. As a result of the diversion, there will be an immediate loss of summer feeding areas for moose which could in turn result in a loss of a potential harvest of 10 to 12 animals. The long-term effect is unknown at this time.

Waterfowl staging areas along the Rat and Burntwood rivers will be lost after flooding. However, waterfowl using the large, open lake areas for short migration stops will not be significantly affected by flooding.

The diversion will likely have some effect on hunting patterns by Nelson House residents. In the past, moose have been hunted along the waterways. This method of hunting will no longer be possible in some areas because many of the shorelines along these waterways will be obstructed by standing timber.

In addition, the competition for game, especially moose, between local residents and non-resident sport hunters is likely to increase as a result of the diversion project and the improved access to hunting areas provided by the Thompson-Leaf Rapids section of Provincial Road 391.

Effect on Local Forestry Activity - During the past year, the sawmill at Nelson House was not in operation; therefore, it provided no income. However, wood is a source of fuel for approximately 154 houses at Nelson House. Assuming a $250 fuel cost per home per year, the value of the fuel wood to Nelson House is $38,500 per year and this is equivalent to 3 percent of total community income.

Flooded trees could provide a source of fuel in the winter time. However, remote communities will depend less on wood as electricity becomes available. Although electric heat is not yet available at Nelson House, new homes are being designed in such a way as to allow for the installation of an electrical heating system. Thus, in the future wood is likely to be less important as a source of fuel.

Effect on Earned Income in the Form of Wages and Salaries - Total earnings in the form of wages and salaries for Nelson House were $744,200 or 58 percent of the total community income in 1972-73. Temporary jobs, mainly in construction, provided $595,000 or 46 percent of community income and permanent jobs provided $149,200 or 12 percent of community income.

There are forty-four permanent jobs in Nelson House. Twenty-four of these jobs are held by Nelson House residents (Table 7-8). Some possibility exists for additional permanent employment of local residents within the community as it is expected that the government will hire more local staff in the future in its administrative and development activities.

An average of fifty-seven temporary or seasonal jobs were held by Nelson House residents. Collectively, these accounted for approximately $595,000 in wages. The jobs were associated with the diversion project and with government financed construction activities in the community. In addition, there was temporary employment in the fur, fishing and forest industries, as well as Local Initiative Programs and Provincial Employment Programs.

An average of forty men were employed by Manitoba Hydro in the Notigi area over the past year and approximately $470,000 in wages were earned. Because of the high turnover rate, the actual number of men employed was much higher. Most of the men employed on the hydro development held jobs that were of an unskilled nature. These consisted of timber clearing and working on survey crews. The majority of men working for the timber clearing contractors engaged in cutting trees while others piled and burned the cuttings. Only a few were heavy equipment operators. The wages earned by the cutters were quite high. One contractor estimated that the men earned up to $1,500 per month. In addition, they received their room and board at a minimal cost of $2.50 per day.

TABLE 7-8
SOURCES OF PERMANENT EMPLOYMENT IN NELSON HOUSE, 1973

| Agency | Total Permanent Jobs | Jobs Held by Local Residents | Resident Income |
|---|---|---|---|
| Hudson Bay Store | 9 | 6 | $ 26,400 |
| School | 22 | 7 | 50,500 |
| Nursing Station | 5 | 3 | 19,500 |
| Band Office | 6 | 6 | 32,200 |
| Department of Mines Resources and Environmental Management | 1 | 1* | 17,000 |
| Manitoba Hydro/Telephone | 1 | 1 | 4,400 |
| TOTAL | 44 | 24 | $150,000 |

* *Plus part-time.*

It is estimated that an average of seventeen jobs were provided by government activities in 1972-73 at Nelson House. The major construction activity over that period was the erection of a school. Throughout the year an average of fifteen men who are local residents were employed. According to the project manager, most of these men were unskilled. However, two were employed as heavy equipment operators. The turnover rate at this job was extremely high. The project manager estimated that to keep a crew operational, a labour pool of four times the number of men working at any one time was required.

Other construction work in the community was associated with government housing programs. There is an ongoing housing program for the community. To date, however, these houses have been built by outside contractors, who hire their own staff. No estimate of the number of jobs in the housing program is available.

Future employment opportunities are difficult to predict; however, jobs in the construction sector will probably decrease rapidly as the hydroelectric project nears completion. A low in employment is anticipated to be reached in 1976.

After that time a few semi-skilled seasonal jobs on a reservoir management program are anticipated to be available at Notigi.

LABOUR FORCE - The population of Nelson House is approximately 1260, consisting of 672 persons 16 years of age and younger, 541 persons between the ages of 16 and 65, and 47 persons 65 years of age or older.

The labour force was estimated by determining the total number of males between the ages of 16 and 65 who are not attending school, and the number of single females between the ages of 16 and 24 who are not attending school. The resulting labour force estimate is 343, as shown in Table 7-9.

TABLE 7-9
NELSON HOUSE LABOUR FORCE, 1972-73

| AGE GROUP | MALE | FEMALE | TOTAL |
|---|---|---|---|
| Under 20 | 46 | 38 | 84 |
| 20 - 40 | 153 | 28* | 183 |
| 40 - 65 | 76 | -** | 76 |
| TOTAL | 275 | 66 | 343 |

* *Ages 20 to 24 inclusively*

** *Not Included*

SOURCE: *Canada Department of Indian Affairs and Northern Development. Manitoba Department of Northern Affairs.*

A significant characteristic of the labour force is the large percentage of unskilled workers. As indicated in Table 7-10, only 3 to 4 percent of the labour force falls into the professional or qualified tradesman category, and 12 percent to 15 percent in the semi-skilled category. Approximately 39 percent to 55 percent are engaged in trapping and/or fishing. Some of the trappers and fishermen may also work for wages. The remaining 35 to 44 percent are unskilled and do not fish or trap.

TABLE 7-10
NELSON HOUSE SKILLS INVENTORY, 1972-73

| LABOUR FORCE | NUMBER | PERCENT |
|---|---|---|
| Skilled | 8-12 | 3-4 |
| Semi-skilled | 40-50 | 12-15 |
| Unskilled | 120-150 | 35-44 |
| Fishermen | 25-45 | 7-13 |
| Trappers | 115-145 | 32-42 |

The majority of the fishermen and trappers are in the 40 to 65 age group whereas the majority of those working for wages are in the 20 to 40 age group. Seventy percent of the trappers are over 45 and some are over 65 years of age. In addition, 60 percent of those in the 40 to 65 age group of the labour force speak little or no English, whereas nearly all of the labour force under 40 years of age can speak English.

Generally, the mobility of the labour force decreases as age increases. As mentioned previously, 60 percent of the over 40 age group do not speak English and the majority are fishermen and/or trappers who do not possess trade skills. Those under 40 years of age do speak English but most are unskilled. Because those under 40 years do not have a language barrier, relocation is easier for them. However, only 18 percent of the men and 8 percent of the women over 14 years of age have indicated that they would be willing to relocate (Table 7-11).

TABLE 7-11
RESULTS OF SURVEY ON WILLINGNESS OF NELSON HOUSE RESIDENTS TO RELOCATE

| | MALE | FEMALE |
|---|---|---|
| Sample size | 158 | 186 |
| Total willing to relocate | 29 (18%) | 15 (8%) |
| Under 40 years of age | 26 | 13 |

EFFECT ON THE LABOUR FORCE - The diversion project is making available large numbers of short-term construction jobs to northern residents. It is estimated that 800 jobs were provided on the Churchill River diversion project in 1974 and 500 jobs will be available in 1975. Most of these jobs require skilled workers; however, some labourers are required.

Many of these jobs require at least some previous training or skills, facility in the English language, and a willingness to move. This willingness to move can be constrained by strong family ties, the difficult adjustment required in moving from the familiar social and cultural milieu of home, and the lack of all-weather road access between home and job site. All these factors are expected to reduce participation by Nelson House residents in the wage economy in general and specifically in the labour market for the diversion project.

A number of workers from Nelson House have shown their willingness to travel outside the community for varying periods of time to take construction jobs. There have been a number of placements of Nelson House workers by the Northern Manpower Corps in jobs at Kettle Rapids, Jenpeg, Notigi, Thompson and other centres. The turnover of these workers is high. On contractor stated that while he employed an average of twenty Nelson House workers at any one time, the total number of residents from Nelson House employed was 100. On the average, forty to fifty men have been employed outside of the community on construction jobs. The majority have worked for bush clearing contractors at the Notigi site.

The diversion project has provided some training to a large portion of the local labour force. While the majority have been employed as labourers, they have received basic training in skills such as carpentry, equipment operation, and cooking.

GOVERNMENT TRANSFER PAYMENTS - In 1972-73, transfer payments in the form of social assistance, social security and family (children's) allowance, made up 28 percent of the community income or $358,000. Social assistance payments consisted of $216,000, family allowances $60,000 and old age pensions $82,000. The social assistance payments were divided into medical, social and unemployed employables categories. Thirty-four percent of the payments were in the medical category, 39 percent in the social category and 27 percent went to unemployed employables.

EFFECT ON GOVERNMENT TRANSFER PAYMENTS - Transfer payments are expected to increase as employment on the diversion project decreases and as more people enter the labour force and are unable to obtain employment. The labour force is expected to increase significantly in the next five years. The resource base of the area does not appear to be capable of providing greater levels of employment than exist at present. There are some future employment opportunities in forestry and in operation of sawmills as well as in tourism throughout the area. Within the community, job opportunities in the service sector are expected to expand, but not substantially. Therefore, unemployment is anticipated to be very high in the future and out-migration from Nelson House will probably occur as jobs become increasingly scarce.

COMMUNITY INFRASTRUCTURE - The level of community services available in Nelson House has steadily increased over the past fifteen to twenty years. At present there is one modern school, nursing station, office facilities for local government, a post office, two stores (including the Hudson's Bay Company), and two churches. Recreation facilities include two halls which are utilized as theatres, hockey rinks and sports fields. Police services are provided by a band constable and Royal Canadian Mounted Police regular patrols. There is neither a centralized water supply and sewage system nor garbage disposal service. The community recently received telephone and television services. Electric power services by diesel generator have been available for a few years.

The transportation infrastructure can be divided into two categories; internal and external. Internal transportation facilities include a gravel road connecting Poplar Point, Dog Point, Mission Point (sometimes referred to as R.C. Point) and the settlement occupied by the non-Registered Indians at Nelson House. The lake is also utilized for transportation in summer and winter. There is no commercial internal taxi or bus service available. However, bus service is provided for the school children.

External transportation services are provided by air, land and water. An airstrip is maintained and operated by the Manitoba Department of Northern Affairs. Charter air services are available from Lambair Limited and Ilford-Riverton Airways Ltd. from Thompson and other larger communities. In addition, Lambair Limited offers two scheduled flights per week from Thompson. Footprint Lake is utilized by floatplane during open water months. Water transportation is generally confined to local travel with the exception of fishermen and trappers who use these natural corridors regularly. Road transportation into the community is provided by an all-weather access road which connects with the Thompson to Leaf Rapids section of Provincial Road 391. Daily bus service to Thompson, Leaf Rapids and Lynn Lake is available.

EFFECT ON COMMUNITY INFRASTRUCTURE - The expected changes in the local water regime will have significant effects on the Nelson House community infrastructure. Potential shoreline effect is of two types: the immediate effect of raised water levels on areas at various levels; and the long-term effect caused by erosion and slumping of banks.

The immediate effect of higher water levels would be to bring shorelines closer to settled areas. In addition, if the elevation of Footprint Lake rises to 810 ft, some areas above this contour will become islands with newly created shorelines. An elevation of 810 ft is expected in the winter months when the Wuskwatim generating station is constructed. Further, elevations of at least this magnitude can be expected during extreme ice jam conditions even without the Wuskwatim project. Under such circumstances, the entire Poplar Point area would become isolated from the rest of the community.

The shoreline at Nelson House is predominantly of clay or silt deposits. Natural wave action against the new banks on such areas will cause erosion of the soil cover and eventual slumping. The extent to which erosion and slumping will occur is dependent on several factors. A rapid and substantial decrease in lake level will cause soil drainage and sliding, as will sudden thawing in permafrost areas. If a generating station is developed at Wuskwatim, it should be possible to prevent ice jams and therefore, extreme fluctuations in water levels at Footprint Lake. The possible effect of increased water levels on permafrost areas is difficult to predict without undertaking further investigations. However, a factor which is likely to contribute to the slumping process is the existence of large cracks which run parallel to the banks at Nelson House.

Areas of Nelson House which could be affected by erosion and slumping include the bank adjacent to the airstrip, several areas near buildings, and four cemetery plots. It is possible to reduce the damage to such areas by applying rock to the banks either before or shortly after flooding.

In Nelson House, the majority of houses and the airstrip are on high ground that is well drained. At present, there are 44 structures below elevation 815 ft. These consist of: 4 public buildings (2 are portable pumphouses); 17 houses, 21 sheds, and 2 main public docks. In addition, a number of small boat wharves will be flooded and modification of one sewer outlet structure may be required.

To protect property adequately from flooding, it will be necessary to prohibit construction below elevation 820 ft because elevation 815 ft is too low to allow a reasonable margin of safety. However, to date, there is no data on property situated between the 815 ft and 820 ft elevation. Thus, the above estimate of flood damage is low. In addition, to protect property from bank erosion, construction should be even further removed from the shoreline.

Ground water is not available and Footprint Lake is used exclusively as the community's water supply source. In general residents draw water directly from the lake, by manual means, for all domestic purposes, including human consumption. Little or no purification takes place. There are two small pumphouses, one to supply Poplar Point and one to supply the new school. A new pumphouse is being constructed to replace both these structures. The new pumphouse will be at elevation 808.0 ft.

All waste disposal is onto or into the ground. Sanitary measures are poor and wastes enter Footprint Lake, creating contaminated water near the shore. A package sewage treatment plant is being constructed. When completed, it will serve the school, nursing station, store and hall.

Short-term changes in the water quality of Footprint Lake due to diversion are expected. In the short-term the turbidity will increase due to shoreline instability throughout the Diversion Route. In the long-term the silt will settle and turbidity should return to pre-diversion levels. The greater silt content will make the water visually less pleasing to the users. Shoreline water will be the most turbid.

Calcium and magnesium salts of bicarbonate will be reduced, but this reduction will go unnoticed, except for a reduction in soap consumption as the water hardness level falls.

Microbiologically, water quality may deteriorate if the flushing action adjacent to the settlement is reduced. Water purification will also become more difficult as turbidity increases since the coliform bacteria adhere to the silt, and it becomes more difficult to separate the bacteria from the water.

No change in waste disposal practices is expected and its influence on water quality will remain the same.

SOCIAL SYSTEM - The community of Nelson House has a relatively good general understanding of the changes in the water regime and the effect this will have on their economy and the infrastructure. They have received information from a variety of sources including local newsletters, radio broadcasts, meetings with government agencies and Manitoba Hydro representatives.

There appears to be a fairly distinct difference between the values of the older people (over about 40-45 years) and those of the younger people. The younger people have a relatively modern world view. Attached to this modern view are new emerging values, particularly in relation to earning a living. Whereas many of the older people are still tied to the traditional activities of hunting, trapping and fishing, the vast majority of the young place a greater value on entering the wage sector of the economy. This emphasis is changing attitudes towards the family and the community, and the general acceptance of greater mobility is decreasing family and community ties. The hydroelectric projects have acted as catalysts in changing these attitudes and values.

In Nelson House, the type of decision-making which has been adopted is not the traditional concensus approach, but is still time consuming in that it involves a heavy input of general public opinion. Issues are raised at a general band meeting and are discussed by all who wish to speak. Following this process of public debate, the chief and council make their decision on the issue. Thus, while the chief and council makes the final decision on most issues, their decisions are based on hearing opinions of those who attend band meetings. Community people are pleased with this public involvement in decision-making and, as a result, feel that people have more commitment to the decisions now than 10 to 15 years ago.

A number of formal organizations and committees have emerged in Nelson House in recent years, some to supplement and assist the role of the elected leaders (chief and council) and some to assist in the operation of other community institutions. There are at present five such committees which operate on a continuing bases and a further two which are organized around annual events or needs.

A number of these committees have gained much confidence and strength in recent years. While most have strong ties of trust and respect with the other organizations to whom they relate, all the committees perceive themselves to be relatively free to pursue the courses of action which they have adopted. However, some of these committees have rather limited or superficial terms of reference and it is difficult to predict how much of this apparent autonomy they would retain if they chose to broaden their scope. It is also the committees with limited mandate which appear to operate quite independently of other community committees. However, there are two committees in particular which are interacting more closely with other community groups, particularly the chief and council, and appear to be constantly testing the limits of their responsibility and authority with a view to expanding their scope.

A committee has been formed to deal with the hydroelectric projects as they concern the community of Nelson House. The formation of this committee and its subsequent activities are solely the result of local initiative and its terms of reference have been determined by the committee in co-operation with the chief and council. The chief and council, which are the supreme formal authority in Nelson House decision-making, have begun to work with these committees and to delegate responsibilities to them on issues within their mandate.

EFFECT ON THE SOCIAL SYSTEM - The social system of the Nelson House community has undergone substantial changes in recent years, and the effect of the hydroelectric project has been to accelerate the rate at which these changes are taking place. The value of community and family ties has been decreasing while the value of entering the wage sector of the economy has been increasing. The rate of this change in values is being increased as a result of the diversion project. Studies indicate that the increase in the rate of change has caused significant stress to the people of Nelson House.

Until mid 1973 the community was not aware that there would be any significant effect on either the community or its surrounding resource base as a result of the diversion project. This sudden awareness gave rise to fears and uncertainties concerning the magnitude of changes to property and resources. Amid these new realities and the emotion surrounding them, it became necessary for the community to make a number of decisions on issues related to the project. For example, a proposal was made to build a dam on the Footprint River south of the community which would isolate Nelson House from some of the flooding.

A related issue requiring community input is the question of whether or not to proceed with legal action which would attempt to stop or delay the hydroelectric projects. The pressures on the community leadership to deal with these issues as well as the need for information concerning specific effects on resources resulted in the formation of the Nelson House Hydro Committee. Subsequently, this committee provided, in part, the impetus to establish the intercommunity Northern Flood Committee. The effectiveness of these committees in arriving at decisions related to these issues has been impeded by a lack of information concerning expected project impacts. This latter situation has been resolved after considerable delay.

The long-term social effect is less clear. The abatement of the present high level of social stress in the community is, in part, contingent upon the ability of the community's decision-making and communications processes to adapt to the changing needs of the community. For example, the need for extensive community consultation in the development of a local employment strategy will necessitate a more complex decision-making process and a more refined method of gathering and distributing information. This, in turn, implies the necessity for a more effective method of information flow between government agencies and the community. In addition, a channel for an awareness by government agencies of community problems, and a willingness to consult and co-operate with the community in arriving at solutions to these problems, is essential if the present level of social stress in Nelson House is to be reduced.

### THOMPSON

Thompson may be categorized as a single industry (mining) northern community. It has been established within the last 15 years to exploit mineral resources in northern Manitoba. The labour force tends to be composed of skilled and highly mobile people. There is no economic reliance on the traditional activities of trapping, fishing and hunting, which are undertaken only as recreation pursuits. Thompson's infrastructure, and its recreation base will be affected by the diversion project.

EFFECT ON COMMUNITY INFRASTRUCTURE - Thompson's floatplane base is located downstream of the city, immediately below the Provincial Road 391 bridge. After diversion debris caused by flooding and bank erosion upstream is expected to be great. This could create a major safety hazard to floatplanes. Manitoba Hydro has proposed the placement of a number of booms which, in combination with the proposed timber clearing program, may mitigate this problem. However, careful monitoring of debris conditions in the area of the floatplane base will be necessary to ensure safety. There is also a possibility of some property damage to docks and other facilities at the base.

Thompson's intake pipe for its water supply is located on the Burntwood River. The increased flows and water levels expected after diversion will necessitate modification to both the Thompson and the Birchtree Mine intakes to prevent disruption of service due to periodic high water levels. The importance of an uninterrupted supply can be indicated by the fact that even a brief shutdown would result in the closing of the International Nickel Company of Canada Limited plant which employs 4000 persons and a stoppage of more than 10 hours could result in no water for the city's emergency services. This problem can be solved through redesign and reconstruction of the water intake system.

The final area of concern is the effect on local recreation alternatives.

The Burntwood River is utilized extensively for recreation in both summer and winter. A local water ski club uses the stretch between Thompson and Manasan Falls and many anglers and picnickners are evident during the summer months. A park, located in Thompson, will be partially flooded and subject to erosion and debris problems. In winter, the river has been used extensively by power toboggan enthusiasts as far upstream as Birchtree Lake. The dramatic increase in flows is expected to cause dangerous ice conditions which will likely disrupt this winter recreation activity. Provision of alternative local facilities away from the Burntwood River area would mitigate this effect. The provision of access to the Partridge Crop Lake area and the development of facilities for picnicking appears to be the most appropriate solution.

# SUGGESTED MEASURES FOR THE DIVERSION ROUTE AREA TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE CHURCHILL RIVER DIVERSION PROJECT

During the course of their investigations on the Diversion Route, agencies under contract to the Board suggested ways to lessen the detrimental effects and to enhance the overall benefits of the Churchill River diversion project. Some of these suggestions were examined in depth and the results along with recommendations for action were reported by the Study Board to the ministers designated under the Study Agreement. However, time and funding constraints prohibited investigation of all suggestions in detail. These measures have been assessed according to whether they will mitigate or enhance effects of the hydroelectric project. The results are presented in Table 7-12. This will serve as a rough guide to those responsible for examining enhancement and mitigation measurers.

TABLE 7-12
SUGGESTED MEASURES FOR THE DIVERSION ROUTE AREA TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE CHURCHILL RIVER DIVERSION PROJECT

| | ● Fish Populations<br>○ Efficiency of Harvesting | ● Wildlife Populations<br>○ Efficiency of Harvesting | ● Forest Resources<br>○ Utilization of Forest Resources | ● Mineral Resources<br>○ Utilization of Mineral Resources | ● Outdoor Recreation Resources<br>○ Utilization of Outdoor Recreation Resources | ● Knowledge of prehistorical and historical cultures | ● Transportation-Navigation services and facilities<br>○ Utilization of Trans-Nav. services and facilities | ● Nelson House Community Income | ● Employment of People from Nelson House | ● Maintain Traditional Life Styles at Nelson House | ● Efficiency of the Social System at Nelson House | ● Community Infrastructure at Nelson House | ● Community Infrastructure at Thompson |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Birchtree and Thompson water supply pumphouses and the outfall from the main sewage plant at Thompson be modified prior to flooding to accommodate projected high water levels. | | | | | | | | | | | | | M |
| *Hunting and fishing activities of construction workers be controlled if necessary to ensure stocks for local people traditionally dependent on the these populations for sustenance. | | | | | | | | M | | | | | |
| Manitoba Hydro, Nelson House and appropriate federal and provincial government agencies continue negotiations to deal with issues arising from the flooding of Indian Reserve Lands at Nelson House. | | | | | | | | M | M | M | M | M | |
| Manitoba Hydro construct the Manasan power development in such a manner as to preserve the falls and adjacent area. | | | | | E | | | | | | | | |
| Appropriate government departments, in consultation with Manitoba Hydro, designate areas in the vicinity of the Notigi Dam which could be used for recreation purposes. | | | | | M | | | | | | | | |
| All floating debris be prevented from entering the vicinity of the float plane base at Thompson. | | | | | | | M | | | | | | |
| Affected sections of Provincial Road 391 and of the Nelson House access road be raised or rerouted prior to being affected by diversion flows. | | | | | | | M | | | | | | M |
| Alternative recreation facilities to the Burntwood River be provided for Thompson residents. | | | | | M | | | | | | | | |
| Native workers be given the opportunity to work on Manitoba Hydro projects and in the mining industry. | | | | | | | | M | M | | | | |
| Large scale investigation of archaeological site UNR 23 be undertaken prior to diversion. | | | | | | M | | | | | | | |
| Small scale investigation of archaeological sites UNR 47, UNR 48, UNR 50, and UNR 52 be undertaken prior to diversion | | | | | | | | | | | | | |
| Dyking off certain areas which are currently productive wildlife areas to avoid loss through flooding | | M | | | E | | | | | | | | |
| Avoid raising water levels after freezeup by more than 1 to 2 ft. | | M | | | | | | | | | | | |
| Potentially productive bays should not be used for booming. | | M | | | | | | | | | | | |
| Experimental clearing be undertaken on the Notigi reservoir. | | | | | | | | | | | | | |
| Nesting sites of ospreys and eagles should not be disturbed. | | M | | | | | | | | | | | |
| Clearing on a acre-for-acre basis should be carried out to replace prime wildlife habitat. | | M | | | | | | | | | | | |
| Following completion of construction activities, temporary buildings should be removed and all debris incinerated. | | | | | M | | | | | | | | |

LEGEND

**M** The suggested measure has the potential to cause the factor to approach the state it was prior to the diversion from the Churchill River.

**E** The suggested measure has the potential to increase the factor to a state greater than it was prior to the diversion from the Churchill River.

*Measures recommended to the Ministers by the Board during the course of the Study.

# FOOTNOTES

[7-1] The Saskatchewan-Nelson Basin Board was established in 1968 under an agreement among the governments of Canada, Manitoba, Saskatchewan and Alberta to study the water resources of the three prairie provinces. The Board submitted a final report in 1972.

[7-2] Underwood, McLelland & Associates Limited, Rat-Burntwood Mitigation Study, prepared for Manitoba Hydro, December, 1973.

# chapter 8

# area 4
# southern indian lake

## GEOGRAPHY

### LOCATION

The Southern Indian Lake study area (Fig. 8-1) is defined as the main body of Southern Indian Lake extending from the southern tip of Swan Bay (latitude 56°36'N) to the northern tip of Moss Lake (latitude 57°41'N). The south-western boundary is Leaf Rapids (56°30'N, 99°55'W) and the eastern and north-eastern boundaries are Missi Falls (98°09'W) and the Waddie River (98°00'W), respectively.

### CLIMATE

The area has a continental climate characterized by short, cool summers and long, cold winters. The mean annual temperature variations of 70° to 75°F from January to July are the greatest of any climate. The mean annual temperature is less than 32°F.

The frost free period is 80 to 90 days in the southern section of the area and 70 to 80 days in the north. Annual precipitation averages 17 inches of which nearly two-thirds falls as rain during the summer months.

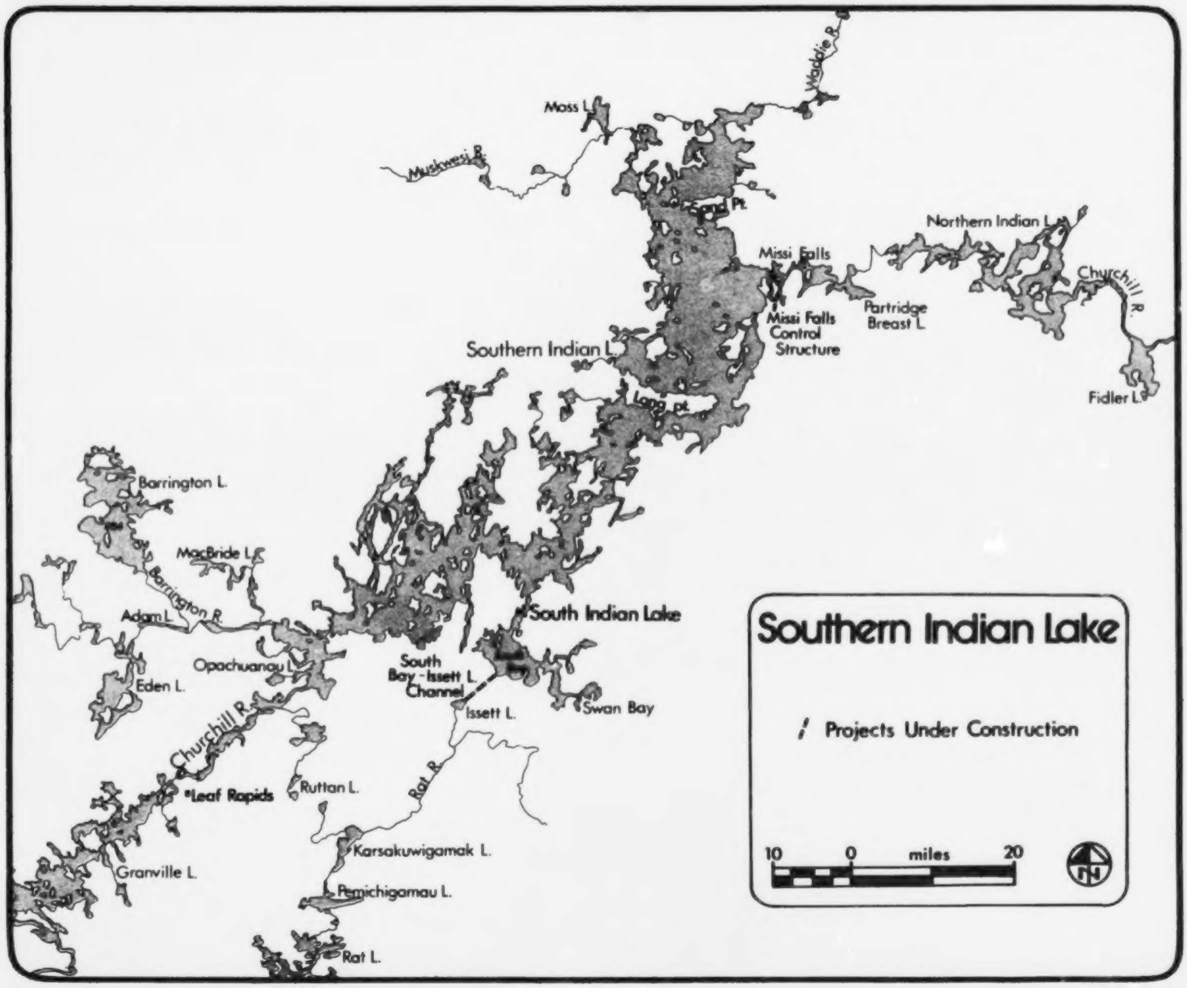

Waddie R.
Moss L.
Muskwesi R.
Sand Pt.
Northern Indian L.
Missi Falls
Missi Falls Control Structure
Partridge Breast L.
Churchill R.
Southern Indian L.
Long pt.
Fidler L.
Barrington L.
MacBride L.
Barrington R.
Adam L.
Eden L.
Opachuanau L.
South Indian Lake
South Bay - Issett L. Channel
Issett L.
Swan Bay
Churchill R.
Leaf Rapids
Ruttan L.
Rat R.
Karsakuwigamak L.
Granville L.
Pemichigamau L.
Rat L.
Southern Indian Lake
Projects Under Construction
10
0
miles
20

Fig. 8-1. Area Map of Southern Indian Lake.

## PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL

The Southern Indian Lake area lies within the Churchill province of the Canadian shield physiographic region. The dominant bedrock is granitic with gneissic and volcanic rock occurring in wide belts. The area was glaciated during the Pleistocene epoch and most current landforms resulted from erosion or deposition by glaciers.

The Bio-Physical Land Inventory divided the area into four Land Districts; Kame Hills, Long Point, South Bay and Rat Lake. Only a small portion of the Southern Indian Lake area lies within the Rat Lake Land District (from Leaf Rapids to the centre of Opachuanau Lake). It is characterized by low-moderate relief with bedrock-controlled uplands. The valleys contain deep lacustrine deposits which may be covered by thin to thick organic accumulations. Permafrost is of local extent in mineral deposits and is discontinuous in organic material.

The western section of the area, the South Bay Land District, has an overall low relief with bedrock-controlled uplands. Lacustrine deposits underlie peat plains and also cover some bedrock upland. Permafrost occurs discontinuously in all materials except esker-kame deposits. The central section of the area, the Long Point Land District, has gently undulating to rolling topography controlled by gneissic and granitic bedrock. There are extensive lacustrine deposits underlain by morainal till and numerous bedrock outcroppings. Peat plains occur in depressions. Permafrost is discontinuous but is present in most types of material. The north-eastern section of the area, the Kame Hills Land District, has low relief peat plains and moderate relief glac[illegible] deposits. There are strongly calcareous glacial till deposits in the north-eastern portion. Lacustrine deposits occur beneath peat. Permafrost is discontinuous.

## VEGETATION

The Southern Indian Lake area lies within the Boreal forest region. The most dominant species in the southern section of this area is black spruce (*Picea mariana*). Sporadic stands of white spruce (*Picea glauca*) occur in areas with better drainage such as flood plains and eskers.

Muskeg is prevalent, with black spruce the major tree species, and sphagnum mosses (*Sphagnum* sp.), feather mosses and Labrador tea (*Ledum groenlendicum*) forming most of the ground cover. A few stands of jack pine (*Pinus banksiana*) occur on dry sites such as eskers and bedrock outcrops. In areas where edaphic and climatic factors are favourable, hardwood stands comprised of white birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*) develop as subseral communities. Dense growths of deciduous trees can be found on burned areas. Willow (*Salix* sp.) and alder (*Alnus* sp.) usually form the first successional stage on moist lacustrine clays and alluvial deposits on lake and stream banks.

In the north, the most common stand is open black spruce with ground cover of lichens (*Cladonia* sp.) and low, prostrate shrubs. On drier sites, the tree canopy is more closed, with denser and higher growth of shrubs. White spruce is found only on flood plains and eskers, while jack pine is present only on dry sites in the southern portion of the zone. Tamarack (*Larix laricina*) occurs frequently in subseral communities.

Most of the denser stands of spruce and mixed-wood occur in a very narrow band along the lake where a moderating influence affords better growth.

## DRAINAGE PATTERNS

Southern Indian Lake is a broadening of the Churchill River. Total drainage area of the Churchill River system is 115,000 square miles, one-third of which lies within Manitoba. Beginning in Alberta, it flows across Saskatchewan, draining the central third of that province.

Southern Indian Lake is 85 miles long and has a surface area of 734 square miles. In addition to the Churchill River, other rivers flowing into the lake include the Barrington, Muskwesi and Waddie rivers. The Churchill River is the only river draining the lake.

## HUMAN HABITATION

There are two communities in the Southern Indian Lake area; South Indian Lake and Leaf Rapids. The population of this area is approximately 2700, the majority of whom live in Leaf Rapids.

The community of South Indian Lake is scattered along the east and west shores of a narrow section of the lake which connects South Bay to the main body of Southern Indian Lake (Fig. 8-2). The total population of South Indian Lake is 590 of which about 400 are Registered Indians. The remainder are non-Registered Indians and non-Indian people.

Fig. 8-2. Aerial Photograph of the Community of South Indian Lake, 1973.

The community of Leaf Rapids is located on the south side of the Churchill River along Provincial Road 391. The population of the community was 2100 in 1973. The town was constructed by a Crown Agency between 1971 and 1974. The majority of the population is employed by Sherritt Gordon Mines Ltd. at the Ruttan Lake mine.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE PHYSICAL ENVIRONMENT

## WATER REGIME CHANGES

Southern Indian Lake in its natural state is fed by the Churchill River at Leaf Rapids and flows back into the Churchill River at Missi Falls. In order to achieve the diversion of substantial flows from the Churchill River into the Rat-Burntwood system a channel is being excavated between South Bay and Issett Lake and natural flows from Southern Indian Lake will be controlled at Missi Falls and Notigi.

The mean monthly modified historic water levels for, and flows from Southern Indian Lake were obtained from the report of the Saskatchewan-Nelson Basin Board. Manitoba Hydro provided the regulated water level and flow data. This information was used by the Water Resources Branch, Manitoba Department of Mines, Resources and Environmental Management, to calculate the water regime for Southern Indian Lake under regulated and unregulated conditions.

The narrows between the main body of Southern Indian Lake and South Bay, where the community of South Indian Lake is located, experience negligible flows. This is due to the fact that only the waters from the small drainage basin area of South Bay pass through these narrows into the main body of the lake. Following regulation, approximately 75 percent of the flow will be diverted through the newly created outlet at South Bay while the remaining 25 percent will be released through the natural outlet at Missi Falls. As a result, flows at Missi Falls will be reduced from an unregulated average of 35,692 cubic feet per second (cfs) to a regulated average of 8857 cfs (Table 8-1). In the unregulated state the minimum mean monthly flow was 22,493 cfs which occurred in April just before breakup (Fig. 8-3). Summer minimums have ranged between 31,070 cfs in August and 26,422 cfs in October. With regulation, flows will be reduced severely with average mean monthly flows ranging from 1500 to 2025 cfs during the period March-April. Furthermore, in dry years when a maximum of water is required in the Rat-Burntwood system, the licence issued Manitoba Hydro under the Manitoba Water Power Act, allows for a minimum flow at Missi Falls of 500 cfs in the open water months and 1500 cfs under ice cover. Related to these lower flows at Missi Falls are substantially reduced flows in the entire north-eastern portion of Southern Indian Lake. In the vicinity of the South Indian Lake community the natural negligible northerly flow will be reversed to a southerly flow and increased dramatically to an average of 26,852 cfs and a maximum of approximately 30,000 cfs (Fig. 8-4 and Table 8-1).

TABLE 8-1
SOUTHERN INDIAN LAKE OUTLETS MEAN MONTHLY FLOWS

| FLOWS | REGULATED | UNREGULATED | CHANGE |
|---|---|---|---|
| MISSI FALLS | | | |
| Maximum | 73,789 cfs | 83,101 cfs | - 9,312 cfs |
| Average | 8,857 | 35,692 | -26,835 |
| Minimum | 500 | 22,493 | -21,993 |
| SOUTH BAY | | | |
| Maximum | 30,000 cfs | | |
| Average | 26,852 | | |
| Minimum | 4,046 | | |

*Note:* *Based on modified historic data for the period 1928-66.*

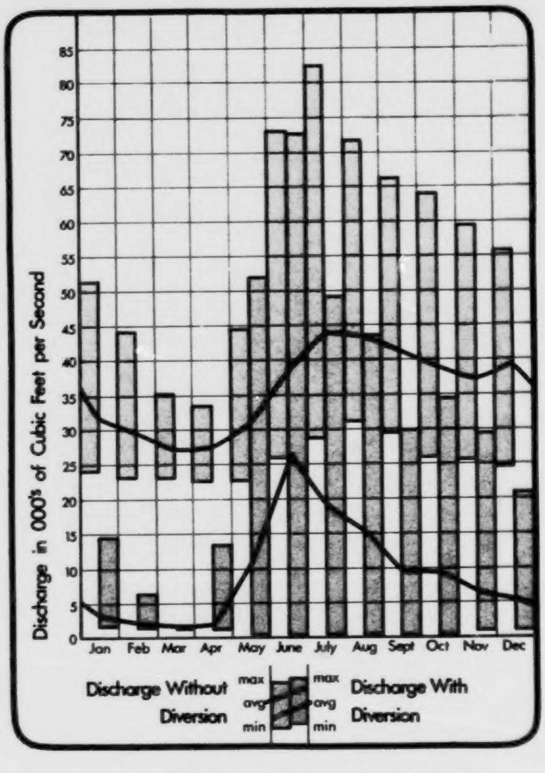


Fig. 8-3. Missi Falls Discharges

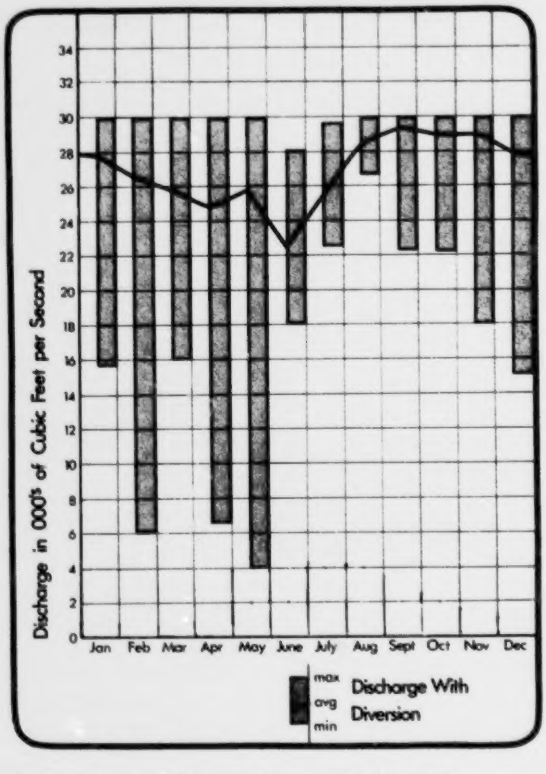


Fig. 8-4. South Bay Discharges

Under unregulated conditions Southern Indian Lake has fluctuated between a minimum mean monthly level of 834.0 ft and a maximum mean monthly of 842.8 ft with an average level of 836.5 ft. Over an annual period the lake fluctuates from a low in April to a high in June and July with an average annual mean monthly fluctuation of 2.8 ft. Under regulation the minimum mean monthly lake levels will be 845.2 ft and the maximum will be 847.0 ft, thus reducing the range experienced in the unregulated state. The average level will be 846.8 ft or 10.3 ft higher than the unregulated state (Table 8-2). Over an annual period the seasonal fluctuations will retain the unregulated pattern but the average annual mean monthly fluctuation will be reduced to 0.5 ft (Fig. 8-5). According to the licence, the annual water level fluctuations cannot exceed 2 ft.

TABLE 8-2
SOUTHERN INDIAN LAKE MEAN MONTHLY WATER LEVELS

| WATER LEVEL | REGULATED | UNREGULATED | CHANGE |
|---|---|---|---|
| Maximum | 847.00 ft | 842.81 ft | + 4.19 ft |
| Average | 846.79 | 836.48 | +10.31 |
| Minimum | 845.17 | 833.98 | +11.19 |
| Range | 1.83 | 8.83 | - 7.00 |

*__Note__: Based on modified historic data for the period 1928-66.*

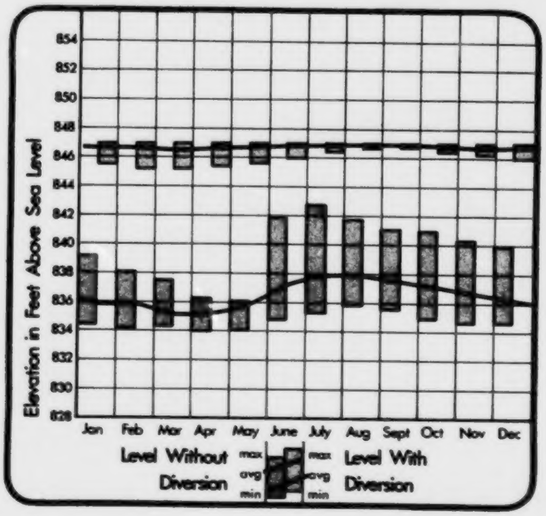


Fig. 8-5.
Southern Indian Lake
Water Levels

## ICE REGIME CHANGES

The diversion of substantial flows from the Churchill River into the Rat-Burntwood system is generally not expected to have significant effects on the ice regime of Southern Indian Lake. However, there is one notable exception. The substantial increases in flows through the narrows will result in long stretches of open water or unsafe ice cover both upstream and downstream from the community. Manitoba Hydro has prepared estimates of probable ice conditions for the channel through the South Indian Lake community after diversion. Estimates vary but they range from 4 to 8 miles of open water through the narrows. It is expected that there will be one area just upstream of the community where an ice cover of 8 inches may form. However, it should be noted that the buildup of this ice cover under the conditions expected, is an uncertain process. The time from the first appearance of ice along the shoreline until the development of a safe ice cover may require the larger part of the winter season, particularly, if snowfall is heavy.

## CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER

In general, water quality analysis indicates that the water from Southern Indian Lake has excellent physical, chemical and bacteriological characteristics with one exception. High coliform counts in the vicinity of the South Indian Lake community render the water unacceptable as a domestic water source without prior treatment.

It is expected that water chemistry and suspended sediments will be significantly changed by diversion. These impacts will vary with the change in the established flow patterns of the lake and the shoreline characteristics. The effects on water quality are discussed in detail in the limnology and community sections.

## PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS

Changes in physical characteristics of the shorelines of Southern Indian Lake were investigated. All shorelines on the lake were categorized according to a system developed by the Department of Civil Engineering, University of Manitoba, 1972. The system derived fourteen typical shoreline profiles for the area based on specific physical characteristics (Table 8-3). The physical characteristics considered included: general morphology, stratigraphy, and composition of shoreline materials; type, zonation, density and size of vegetation; drainage characteristics; and the occurrence of permafrost.

TABLE 8-3
SOUTHERN INDIAN LAKE
SHORELINE CLASSIFICATION SYSTEM

| TYPE | CATEGORY | CLASSIFICATION |
|---|---|---|
| 11-15 | Bedrock and Bedrock-controlled | 11 Steep bedrock shoreline<br>12 Vertical bedrock shoreline<br>13 Low bedrock shoreline<br>14 Bedrock-controlled shoreline with overburden beach<br>15 Low bedrock-controlled shoreline |
| 21-28 | Alluvium or Overburden | 21 Ice-scoured till bank<br>22 Shoreline in coarse sediments<br>23 Mild-sloped alluvial shoreline<br>24 Low alluvial shoreline<br>25 Shoreline in slumping overburden<br>26 Treed muskey shoreline<br>27 Low shoreline in coarse sediments<br>28 Low willow shoreline |
| 31 | Organic | 31 Floating fen |

Bedrock-controlled shoreline can vary from steep bedrock cliffs with no overburden to gently sloping banks with an overburden beach. The shoreline shape is determined by the topography of the exposed or underlying bedrock. Four basic types of this shoreline are prominent on Southern Indian Lake. Type 11 is a steep bedrock with sparse overburden. The next three types, 13, 14, and 15, are generally associated but with significant differences at the land-water interface. Type 13 is generally found at exposed headlands which are interspersed by type 14 and 15 in more protected areas. Because of the exposure to wave action, type 13 generally has a rather wide, wave-washed rocky beach while type 15 has bedrock exposed only narrowly at the water's edge. Type 14, as opposed to the other bedrock-controlled types has a beach made of overburden materials (clay or sand).

Shorelines of alluvium or overburden (types 22 to 28) are the second broad classification. Generally speaking, this type of shoreline is very gentle. Type 22 forms regular shorelines, usually with wide sand or gravel beaches. Ice-contact material such as esker or kame deposits form the underlying constituents. Type 27 is generically related to 22, but is found where deposits are thinner. Type 23, found along river channels, is characterized by a layer of overburden 3 to 6 ft deep over bedrock of low relief. Type 24, the low alluvial shoreline, is typically found at the mouths of small tributaries. The remaining types of alluvial or overburden shoreline have low slopes and poor drainage which favor the accumulation of organic materials. Type 26, the treed muskeg, has a thick peat sequence at the surface, often outcropping on the typically steep backshore bank. Because of the thick organic cover, permafrost is common. Organic overburden is less developed on the type 28, low willowed shoreline, but permafrost is still common. Relief is low and typically an offshore zone of marsh vegetation is present.

The last shoreline type (type 31) is almost entirely organic. A wide water-saturated beach of black organic mud leading to a low ridge protects a floating fen of extensive saturated peat.

Areas exhibiting similar shoreline types are grouped into reaches (Fig. 8-6) to facilitate the discussion of the area. In general, the northern portion of Southern Indian Lake is identified by low lacustrine relief and occurrence of granular material, while the southern reaches are characterized by the high occurrence of bedrock-controlled shorelines. The following section will cover each specific reach.

Moss Lake, Hammond Point, Waddie River (Reach 1) - This reach occupies the extreme northern sections of Southern Indian Lake (Fig. 8-6). Moss Lake is characterized by extensive offshore marshes, and very little bedrock is exposed (Table 8-4). The Muskwesi River has mainly low alluvial shorelines.

The central region, Hammond Point and the northern section of Moose Point, contains sections of bedrock control and of coarse material shorelines. Most headlands are low bedrock shoreline (25 miles), separating long stretches of bedrock-controlled shoreline (26 miles). On Hammond Point headlands are low, bedrock-controlled.

The Waddie River area is characterized by a local esker complex and contains a fair length (11 miles) of coarse grained material shoreline. There are also stretches of low shoreline in coarse sediments, low alluvial shoreline and treed muskeg shoreline. Exposed bedrock is almost non-existent.

In Reach 1, the shoreline impact of diversion will be the most severe of the entire Southern Indian Lake area. Low relief and permafrosted mineral soil are not conducive to the formation of a natural looking shoreline.

The Moss Lake region will contain several miles of inundated trees. The Little Sand and Muskwesi River systems will become a portion of a newly created lake. The marsh communities on the western shore of Moss Lake will not likely redevelop to their present state and floating matts of fen and sedge will exist among the flooded timber.

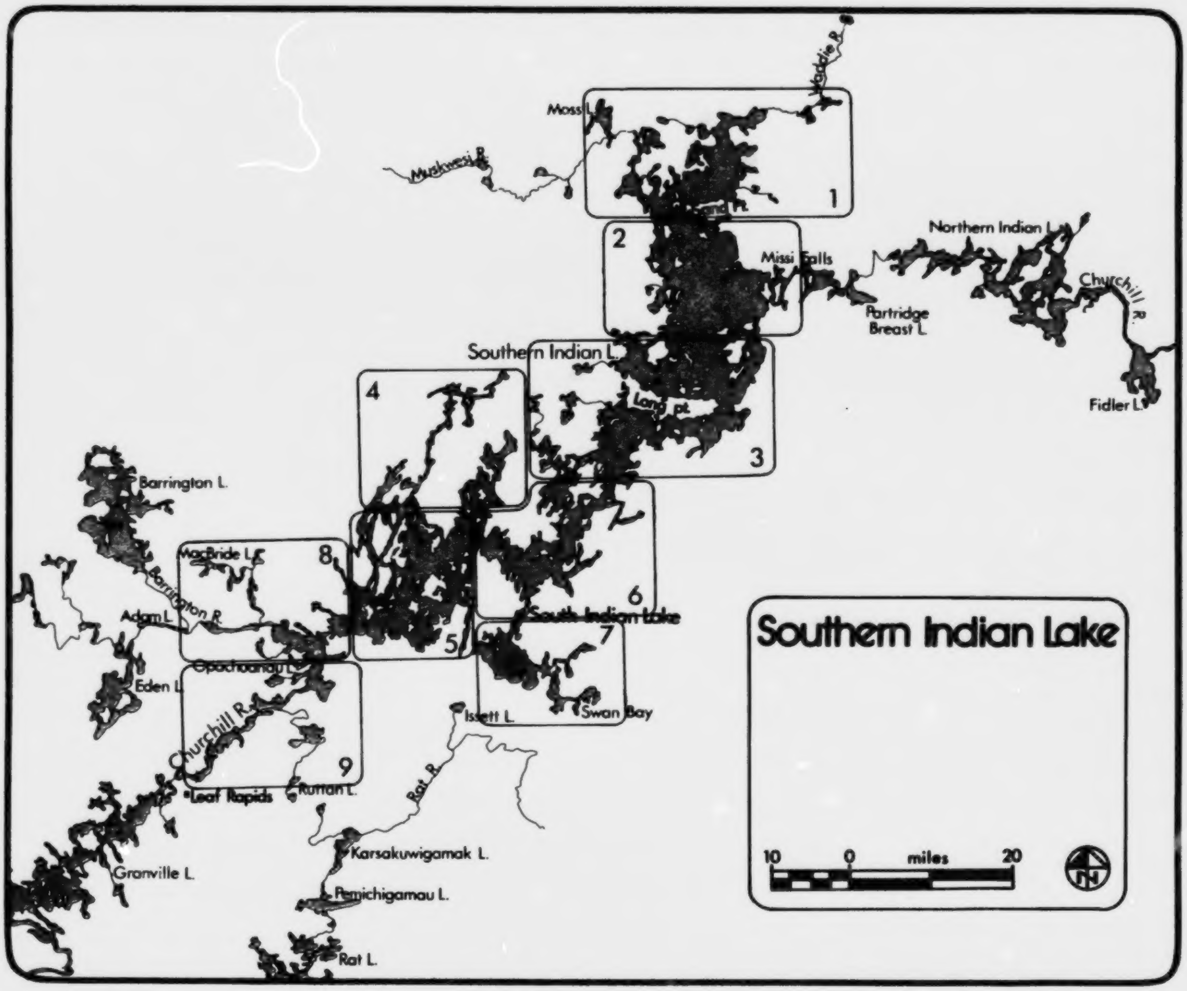

Waddie R.
Moss L.
Muskwesi R.
1
2
Missi Falls
Northern Indian L.
Churchill
20
Partridge Breast L.
Fidler L.
Southern Indian L.
Long pt.
3
4
Barrington L.
MacBride L.
8
Barrington R.
Adam L.
5
6
South Indian Lake
7
Opachuanau L.
Eden L.
Churchill R.
9
Leaf Rapids
Ruttan L.
Issett L.
Swan Bay
Rat R.
Karsakuwigamak L.
Pemichigamau L.
Granville L.
Rat L.
Southern Indian Lake
10
0
miles
20

Fig. 8-6. Map of Shoreline Reaches of Southern Indian Lake.

TABLE 8-4
SOUTHERN INDIAN LAKE SHORELINE TYPES (in miles)

| Classification | 11 | 13 | 13m | 14 | 14B | 14m | 14mB | 15 | 15B | 15m | 15mB | 22 | 22m | 23 | 24 | 24m | 26 | 26B | 26m | 27 | 27m | 28 | 28m | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Moss Lake | - | 9.8 | 2.3 | 1.6 | 0.3 | 4.2 | 2.6 | 1.1 | - | 2.7 | - | 0.6 | - | - | 28.9 | 2.7 | 0.5 | - | - | 0.8 | 1.8 | 0.2 | - | [illegible] | [illegible] |
| Waddie River | - | 1.0 | - | 2.0 | - | - | - | 2.3 | - | 0.8 | - | 9.5 | 1.4 | - | 6.2 | - | 10.1 | 0.4 | - | 0.8 | 0.5 | 3.5 | - | - | [illegible] |
| Hammond Point | - | 25.0 | - | 7.2 | 4.9 | 10.0 | 4.2 | 31.1 | 0.2 | 2.2 | - | 11.5 | 2.7 | 0.1 | 5.1 | 4.1 | - | - | - | 0.1 | - | 0.9 | 2.6 | 0.6 | [illegible] |
| Missi Falls | 5.9 | 117.1 | - | 17.6 | 5.6 | 10.1 | 0.9 | 29.8 | - | - | - | 5.3 | 3.7 | - | 3.1 | 2.0 | 1.3 | - | - | - | - | 0.3 | - | - | 202.7 |
| Long Point | 32.0 | 197.0 | - | 8.2 | 4.7 | 2.3 | 0.3 | 29.8 | 1.5 | - | - | 4.3 | - | - | 12.8 | 0.5 | 0.5 | - | - | 0.7 | - | 3.3 | 0.5 | - | 298.4 |
| Mulcahy Lake | 140.6 | 52.3 | 11.5 | 6.5 | 1.0 | 6.9 | 0.1 | 0.5 | - | - | - | 0.2 | - | 1.2 | 3.7 | 6.9 | - | - | - | - | - | 0.1 | 0.1 | 0.8 | 232.4 |
| Lemay Island | 31.7 | 283.8 | - | 0.2 | 17.0 | 11.5 | 11.1 | 16.2 | - | - | - | - | - | - | 1.6 | 0.6 | - | - | - | - | - | - | - | - | 373.7 |
| The Community | 24.8 | 119.9 | - | 17.2 | 5.1 | 11.9 | 0.2 | 26.8 | - | - | - | 10.1 | - | 1.9 | 5.1 | 0.6 | 0.9 | - | 0.1 | 3.7 | - | - | - | 0.6 | 228.9 |
| South Bay | 4.6 | 26.8 | - | 19.8 | 4.6 | 9.4 | 0.4 | 8.0 | 4.5 | 2.4 | 1.6 | - | - | - | 0.5 | 1.8 | 3.5 | 2.4 | 1.6 | 0.4 | - | 0.5 | - | - | 92.8 |
| Opachuanau | 9.2 | 73.2 | 1.4 | 2.8 | 1.3 | 2.0 | 0.6 | 2.7 | - | 0.3 | - | 2.3 | 0.2 | 0.6 | 2.4 | 0.1 | 0.1 | - | - | - | - | 0.2 | 0.2 | 1.9 | 101.5 |
| Leaf Rapids | 9.0 | 31.8 | 2.0 | 3.7 | 0.5 | 2.8 | 0.1 | 5.4 | - | 2.1 | - | 0.9 | - | - | 3.0 | 0.8 | - | - | - | 0.4 | - | 0.2 | 1.6 | 0.3 | 64.6 |

B - *open sand or gravel beach*
m - *offshore marsh zone*

Many islands will be created in the central region. The bedrock-controlled and coarse material shorelines should become stable within 50 years. Overburden will be eroded back at least 20 ft before the shoreline stabilizes. Flooding will be greatest in the areas north of Hammond Point and the present marsh vegetation will be flooded out. Beaches in the south-eastern section should attain a stable state early in the post-diversion period.

In general, the Waddie Lake area will recover quickly due to the extent of the granular materials. The free floating sedge matts will form portions of the new shoreline.

Missi Falls (Reach 2) - This area includes the falls as well as Moose Point and Loon Narrows (Fig. 8-6). The northern portion of the reach from Moose Point to Bear Narrows is typified by long, wide coarse grained material shoreline. This is an esker-kame complex (Table 8-4). The rest of the area includes large sections of low bedrock with deep backshore overburden, bedrock-controlled, and low bedrock-controlled shorelines.

After diversion the overall water line setback will be about 20 ft. A natural state shoreline will be achieved earliest within the esker-kame complex. Most of the small islands will be inundated.

Long Point (Reach 3) - The Long Point area has 298 miles of shoreline. There is a high occurrence of steep bedrock shoreline (32 miles) and a pronounced depth of overburden (Table 8-4). The north-eastern portion is mostly bedrock-controlled, and the northern section contains a variety of coarse materials offshore. In the south, the shoreline consists of bare rock covered by boulders. Long Point consists of a series of bedrock headlands, embayments and low willow shoreline.

Much of the backshore consists of treed muskeg with permafrosted mineral soil below the peat layer on many of the sites.

After diversion there will be a fair amount of erosion occurring along the low bedrock shorelines. A stable shoreline should be achieved fairly soon. Long Point itself will become an island, thereby decreasing the travelling distance from the community to Loon Narrows.

Mulcahy Lake (Reach 4) - This area is west of Long Point (Fig. 8-6) and consists of a series of channels and a number of lakes dotted with islands. Steep bedrock accounts for 141 miles of the 232 miles of shoreline (Table 8-4). The remainder of the shoreline is primarily low bedrock and bedrock-controlled. These bedrock areas alternate with steep bedrock throughout the entire reach.

Due to the dominance of steep bedrock shoreline the impact of diversion will be minimal in this reach. Flooding will be greatest within the tributaries and bays.

Lemay Island (Reach 5) - This is the largest reach in Southern Indian Lake (Fig. 8-6). There are many islands within this area. Most of the shoreline is bedrock-controlled. Shoreline types include: steep bedrock, bedrock-controlled with overburden beach and marshes, low bedrock and low bedrock-controlled. There are no granular or low lying shorelines (Table 8-4).

Impact after diversion will be typical for the whole area. The majority of islands will be reduced in size and the clay banks will erode back about 40 ft. The marshes and overburden beaches will not resume their pre-diversion size.

The Community (Reach 6) - Sandhill Bay to the north and the South Indian Lake community to the south are included in Reach 6 (Fig. 8-6). Sandhill Bay contains 10 miles of shoreline with overburden of coarse grained sediments. The beach itself often consists of a thin, sand veneer overlying the lacustrine clay. Other shoreline types include low shoreline in coarse sediment and coarse grained shoreline. The rest of the lake is bedrock-controlled.

Impact will be less in the Sandhill Bay area due to the extensive granular overburden. The impact of anticipated shoreline change on real property is discussed in the community section.

South Bay (Reach 7) - Poplar Narrows and Swan Bay are included in this reach. There are few islands and much of the shoreline has a thick lacustrine clay overburden. Major shoreline types are: bedrock-controlled, low bedrock-controlled, low bedrock, steep bedrock, treed muskeg and low alluvial.

Considerable erosion will occur with diversion, with shoreline recession from 60 to 80 ft. Steep, high, overburden banks will form. A slash-only timber clearance operation has been done, by Manitoba Hydro, to the 850 ft contour. These felled trees will float into the Notigi Reservoir after diversion.

Opachuanau Lake (Reach 8) - Opachuanau Lake and the Barrington River are in this reach. The area contains a great variety of shoreline types (Table 8-4).

Impact will be varied and not too severe. The river system itself will achieve a natural state before the lake but both will be in a natural state within a 50-year period.

Leaf Rapids (Reach 9) - This reach contains 65 miles of the Churchill River shoreline. The majority of this reach is bedrock-controlled. Other common types include steep bedrock, and low bedrock shorelines.

The impact in this reach will be very similar to that on Opachuanau Lake. In addition, some back flooding of nearby lakes will take place.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION

## LIMNOLOGY AND FISHERIES

The Fisheries and Marine Service, Canada Department of the Environment, investigated and reported on the effects of the raised levels and changes in flow patterns on the aquatic ecosystem. The current status of the limnology-fisheries information and the historical fishery exploitation was examined and fishery potentials and critical factors in productivity were defined. Field investigations included studies on: the chemical budget, primary production, zooplankton and benthos, and the fisheries.

LIMNOLOGY - Southern Indian Lake has a total water surface area of 734 square miles and a mean depth of 30.2 ft (maximum depth 121.4 ft). Total length of shoreline is 2180.9 miles (including islands) and total water volume is 14,100,000 acre-feet.

To facilitate discussion on an area as large as Southern Indian Lake, the lake is divided into seven geographical regions according to basin structure and chemical impact of the Churchill River (Fig. 8-7).

Southern Indian Lake is isothermal during the ice-free season. Water temperatures did not exceed 68°F during the course of the study. The Churchill River exerts a warming influence in region 1 in the spring. Dissolved oxygen ranges from 67 to 110 percent saturation and the lake is near saturation most of the year.

Although the lake is situated on the Precambrian shield, the dominant surface materials adjacent to the lake are glaciolacustrine clays. Weathering of these surface materials and the large discharge of the Churchill River result in a high turbidity. This discharge also results in a rapid renewal time for the lake. Transparency is low with Secchi disc depths ranging from 1 to 2.5 metres. The Churchill River is relatively high in sodium and potassium concentrations and low in calcium and magnesium compared to local shield waters. Much of the sand and silt contributed by the Churchill River is deposited soon after entering the lake. Bottom topography and exposure to wind are the dominant factors controlling sediment distribution.

The Churchill River is the overwhelming source of nutrients to the lake. Although concentrations of nutrients in the river are similar to those in local streams, the large discharge yields a very high annual nutrient loading. The highest loading is confined to those lake regions directly influenced by the Churchill River (regions 1-4) where annual loading exceeds 0.5g phosphorus/m$^2$. South Bay (region 6), north of Sand Point (region 5), and the north-western area (region 7) of the lake have much lower loading rates (less than 0.03 g P/m$^2$ annually). These low-loading regions have very little interchange with the Churchill River and possess distinctive chemical (major ions) and biological properties.

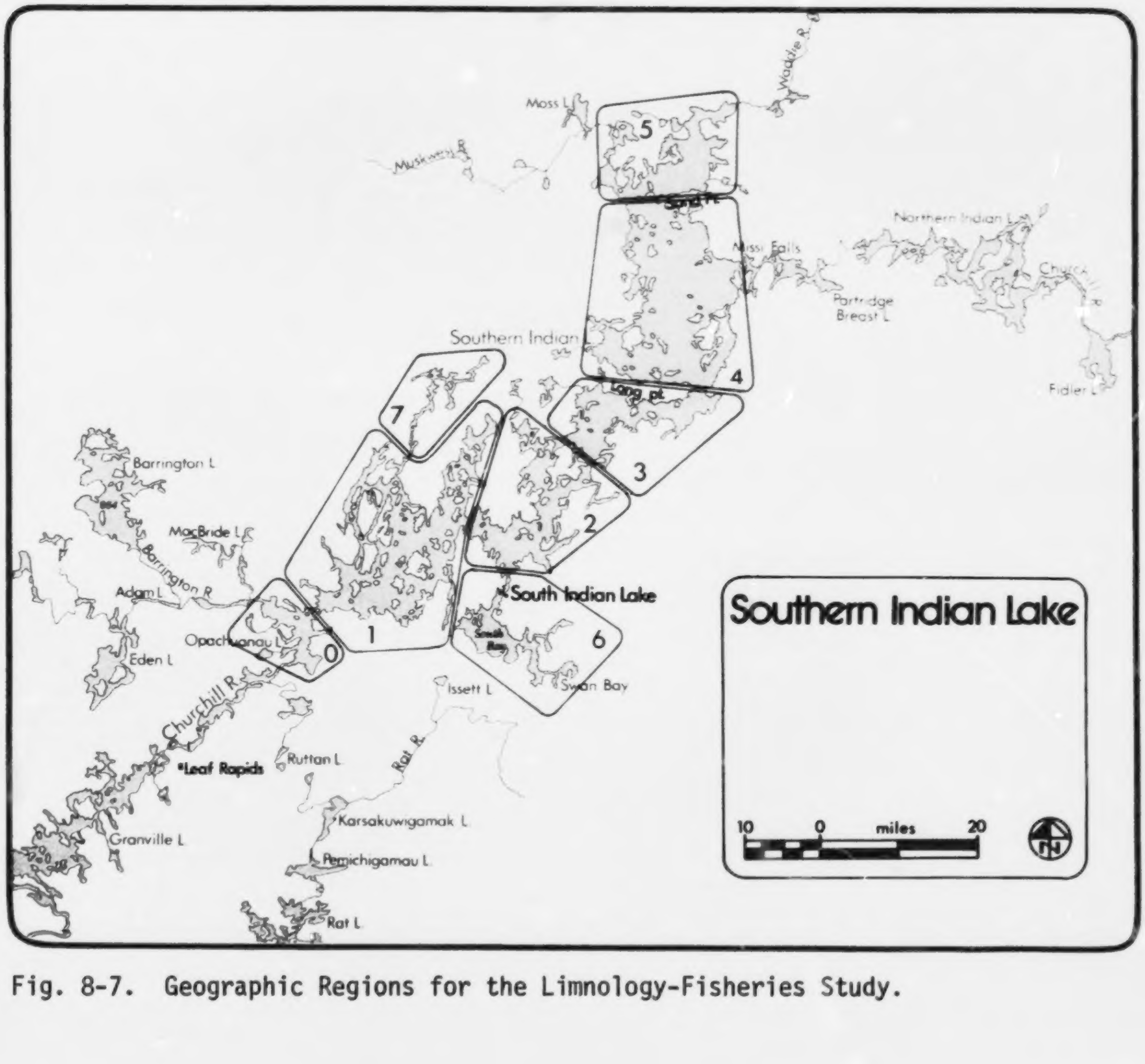

Southern Indian Lake
Moss L
Waddie R.
Muskwesu R.
Sand Pt.
Northern Indian L
Missi Falls
Churchill
Partridge Breast L
Fidler L
Southern Indian L
Long pt.
Barrington L
MacBride L
Barrington R.
Adam L
Opachuanau L
Eden L
Churchill R.
South Indian Lake
South Bay
Swan Bay
Issett L
Rat R.
Rutton L
Leaf Rapids
Karsakuwigamak L
Granville L
Pemichigamau L
Rat L
0
1
2
3
4
5
6
7
10
0
miles
20

Fig. 8-7. Geographic Regions for the Limnology-Fisheries Study.

Algal standing crops and productivity correlate with the relative loading; but algal biomasses are lower than would be expected from the loading rates (maxima observed, 4400 mg/m$^3$ biomass and 9 mg/m$^3$ chlorophyll). Fine suspended clays limit nutrient utilization and phytoplankton growth. There are two distinct seasonal maxima in algal standing crops with diatoms of the genus *Melosira* predominating at both. The interplay of turbidity and mixing depth affects the size of algal crops and primary productivity. Maximum algal standing crops and primary production occur in the large basin north of Long Point (region 4) where the combination of relatively high light penetration and nutrient-rich Churchill River water produce the best conditions for algal growth in the lake. Similar light conditions are found north of Sand Point (region 5) which allows this region of the lake despite its low nutrient loading, to sustain algal growth comparable to several lake regions influenced by the Churchill River. South Bay (region 6) has low light penetration and low nutrient loading and consequently has the lowest algal production in the lake.

The number of zooplankton species (30) is extremely high, reflecting the complex nature of the multi-basin lake. The distribution of these species reinforces the chemical data which indicates that regions 5, 6 and 7 have very little interchange with the Churchill River. The species also show an east-west differentiation within the main lake (regions 1-4). This distribution suggests that the main Churchill River plume occupies the eastern portion of the lake while the western side is influenced by local drainage.

The freshwater shrimp (*Pontoporeia affinis*) is the most abundant benthic organism in all regions of the lake excepting South Bay (region 6). Midge larvae (Chironomidae) and fingernail clams (Sphaeriidae) are the other two most abundant benthic organisms. The flow of the Churchill River has a marked influence on densities of benthic invertebrates. Regions isolated from the Churchill River have 29 percent fewer organisms and 52 percent fewer *Pontoporeia* than regions directly influenced by the flow of the Churchill River.

At least nineteen fish species are present in Southern Indian Lake including lake whitefish (*Coregonus clupeaformis*), northern pike (*Esox lucius*), yellow walleye (*Stizostedion vitreum vitreum*), sauger (*Stizostedion canadense*), perch (*Perca flavescens*), cisco (*Coregonus* sp.), and suckers (*Catostomus* spp.). Fish populations are very good for a shield lake with the most abundant commercial species being whitefish, walleye, and northern pike. However, rates of growth and condition of fish are not exceptional. There is also a good variety of coarse fish with white sucker (*Catostomus commersoni*), predominating in almost all areas. Whitefish spawn in all regions but their greatest concentrations are found in region 4. Walleye migrate to at least eight major spawning tributaries in Southern Indian Lake.

EFFECT ON LIMNOLOGY - With diversion, the higher water levels on Southern Indian Lake will increase the water surface area from 734 to 935.7 square miles (Table 8-5) or by 28 percent. Volume will increase from 14,100,000 to 20,200,000 acre-feet (30 percent) and mean depth from 30.2 to 33.8 ft (12 percent). The increase in mean depth will not alter the usual isothermal summer conditions.

TABLE 8-5
AREAS, VOLUMES, MEAN DEPTHS AND EXCHANGE TIMES OF SEVEN REGIONS OF SOUTHERN INDIAN LAKE AND OPACHUANAU LAKE AFTER DIVERSION

| WATER AREA | REGION 1 | REGION 2 | REGION 3 | REGION 4 | REGION 5 | REGION 6 | REGION 7 | TOTAL EXCLUDING REGION 0 | REGION 0 OPACHUANAU LAKE |
|---|---|---|---|---|---|---|---|---|---|
| Total area | | | | | | | | | |
| sq. meters x $10^6$ | 667.5 | 349.4 | 306.2 | 870.0 | 369.4 | 149.9 | 68.2 | 2780.6 | 103.0 |
| (sq. miles) | (257.7) | (134.9) | (118.2) | (335.9) | (142.6) | (57.9) | (26.3) | (1073.6) | (39.8) |
| Island area | | | | | | | | | |
| sq. meters x $10^6$ | 132.1 | 53.3 | 38.4 | 94.1 | 31.6 | 4.6 | 3.3 | 357.4 | 6.5 |
| (sq. miles) | (51.0) | (20.6) | (14.8) | (36.3) | (12.2) | (1.8) | (1.3) | (138.0) | (2.5) |
| Water area | | | | | | | | | |
| sq. meters x $10^6$ | 535.4 | 296.1 | 267.9 | 775.9 | 337.8 | 145.6 | 64.9 | 2423.4 | 96.6 |
| (sq. miles) | (206.7) | (114.3) | (103.4) | (299.6) | (130.4) | (56.2) | (25.1) | (935.7) | (37.3) |
| Volume | | | | | | | | | |
| cu. meters x $10^9$ | 5.75 | 2.71 | 2.66 | 10.37 | 2.07 | 0.93 | 0.40 | 24.89 | 0.71 |
| (acre-feet x $10^6$) | (4.66) | (2.20) | (2.15) | (8.41) | (1.67) | (0.75) | (0.33) | (20.17) | (0.58) |
| Mean depth | | | | | | | | | |
| meters | 10.7 | 9.2 | 9.9 | 13.4 | 6.1 | 6.4 | 6.2 | 10.3 | 7.4 |
| (feet) | (35.1) | (30.2) | (32.5) | (43.9) | (20.0) | (21.0) | (20.3) | (33.8) | (24.3) |
| Shoreline length total | | | | | | | | | |
| kilometers | 1029.6 | 512.3 | 281.2 | 756.9 | 551.2 | 255.5 | 208.0 | 3594.7 | 193.5 |
| (miles) | (639.8) | (318.4) | (174.7) | (470.3) | (342.5) | (158.7) | (129.3) | (2233.7) | (117.8) |
| Lake outline | | | | | | | | | |
| kilometers | 379.6 | 241.3 | 147.3 | 339.1 | 360.7 | 210.4 | 130.8 | 1809.2 | 163.9 |
| (miles) | (235.9) | (150.0) | (91.5) | (210.7) | (224.1) | (130.7) | (81.3) | (1124.2) | (101.8) |
| Island outline | | | | | | | | | |
| kilometers | 650.0 | 271.0 | 133.9 | 417.8 | 190.5 | 45.1 | 77.2 | 1785.5 | 29.6 |
| (miles) | (403.9) | (168.4) | (83.2) | (259.6) | (118.4) | (28.0) | (48.0) | (1109.5) | (16.0) |
| Flow | | | | | | | | | |
| cu cm/sec x $10^6$ | 889.1 | 496.8 | 107.0 | 110.8 | 25.7 | 893.9 | 19.4 | - | 889.1 |
| (cfs) | (31,400) | (17,544) | (3,779) | (3,912) | (909) | (31,567) | (685) | - | (31,400) |
| Exchange time | | | | | | | | | |
| Days | 74.9 | 63.1* | 287.7 | 1083.5 | 930.8 | 12.0 | 238.7 | - | 9.2 |
| Years | 0.2 | 0.2 | 0.8 | 3.0 | 2.54 | 0.03 | 0.7 | - | 0.03 |
| Shoreline development factor | | | | | | | | | |
| excluding islands | - | - | - | - | - | - | - | 10.4 | 4.7 |
| including islands | - | - | - | - | - | - | - | 20.5 | 5.4 |

* *Assuming one half of region 2 receives the full Churchill River flow, 31,400 cfs and one half receives 3,800 cfs the exchange time would be 17 days for the upper half and 147 days for the lower half of region 2.*

The Churchill River determines the chemical composition and nutrient loading rate of regions 1-4 of Southern Indian Lake. South Bay, region 6, which now receives negligible amounts of Churchill water, will receive most of the river flow under diversion. The water chemistry of regions 3, 4 and 6 will therefore be significantly altered by diversion. The reduced flow will ensure that local drainage more strongly influences regions 3 and 4; increases in total dissolved solids, calcium and magnesium will occur. In South Bay (region 6) the opposite changes will occur. Nutrient loading to regions 3 and 4 will be drastically reduced (from 0.53 g P/m$^2$ to 0.08 g P/m$^2$). Sediment loading will also be reduced and thus lower turbidity will improve light environment, and longer residence time for the water will offset to a certain extent the reduction in nutrient loading.

The formation of new shorelines will have profound effects on sedimentation in the lake. The shoreline types will vary markedly in their response to higher water levels. Low bedrock shoreline (type 13) has the greatest potential for sediment yield affecting a large area. Its effects are likely to be more immediate that the others. A long-term release will result from bedrock-controlled shorelines (types 14 and 15), the effects of which will be more localized. Coarse materials and low slope reduce the potential for widespread sediment release from these areas. Fen shorelines (type 31) are potentially quite troublesome. Table 8-6 rates each shoreline type as to potential detrimental effect on water quality. Regions 3 and 4 will be the areas most affected by shoreline stabilization. Increased nearshore siltation will affect whitefish spawning grounds and the habitat of benthic organisms. Increased turbidity can lead to a reduction in primary production; however, loss of turbid Churchill River water could lead to a reduced loading of suspended sediment. Region 5 has a large potential for the release of floating debris.

Diversion will drastically alter productivity patterns in the lake as the high nutrient loading is redistributed. Suspended materials from eroding shorelines will increase turbidity and reduce productivity near the new shorelines. Annual algal production in regions 3 and 4 is expected to decline from one-half to two-thirds of the present level (Table 8-7).

The longer residence time (increasing from less than 3 months to more than 2 years) may lead to increased standing crops of zooplankton. The positive influences of Churchill River flow which was discussed earlier will increase the productivity of region 6 (Table 8-7). Biological production after diversion will drop significantly in the central and northern parts of the lake.

It is estimated that overall benthic production in Southern Indian Lake is

TABLE 8-6
PRINCIPAL SHORELINE TYPES ON SOUTHERN INDIAN LAKE AND THEIR PROBABLE CONTRIBUTION TO SEDIMENTATION AND IMPACT

| Class | | Potential release | Dispersion | Timing | Primary target function | Potential severity |
|---|---|---|---|---|---|---|
| Bedrock controlled | | | | | | |
| 11 | Steep bedrock | negligible | insignificant | not significant | not significant | nil |
| 13 | Low bedrock shoreline (wide wave-washed bedrock beach zone; backshore overburden thin to moderate) | slight to large | widespread | rapid | turbidity reduced primary production | great |
| 14 | Bedrock controlled shoreline with overburden beach | large | local to widespread | slow | turbidity and siltation; benthos and primary production and spawning | moderate to great |
| 15 | Low bedrock-controlled shoreline (narrow bedrock exposure beach often overhung by overburden; slope equal to or greater than 13) | large | local to widespread | slow to moderate | turbidity and siltation; benthos and primary production and spawning | moderate to great |
| Alluvium or overburden | | | | | | |
| 22 | Shoreline in coarse sediments | very large | local | rapid | siltation; benthos production and spawning | slight |
| 24 | Low alluvial shoreline | light or moderate | local | rapid | siltation; benthos production and spawning | moderate |
| 26 | Treed muskeg | moderate | local to widespread | moderate | turbidity and siltation; benthos and primary production and spawning | great |
| 27 | Low shoreline in coarse sediments | light | local | moderate | siltation; benthos production and spawning | slight |
| 28 | Low willowed shoreline | light to moderate | local | great | siltation; benthos production and spawning | moderate |
| Organic | | | | | | |
| 31 | Fen shoreline | moderate | local to widespread | rapid | turbidity and siltation; benthos and primary production and spawning | great |

TABLE 8-7
PARAMETERS INDICATIVE OF GENERAL BIOLOGICAL PRODUCTIVITY OF LAKE REGIONS UNDER PRE- AND POST-IMPOUNDMENT CONDITIONS.
IN COLUMNS 1-8, 100 PERCENT = MAXIMUM VALUE IN THE LAKE AT PRESENT AND
OTHER NUMBERS ARE PROPORTIONAL. IN COLUMNS 9 AND 10, NUMBERS ARE PERCENT OF TOTAL (= 100) UNDER PRESENT CONDITIONS.

| Source | Region | (1) Nutrient loading (annual) | | (2) Light (June-Oct) | | (3) Conditions for Phytoplankton production (Average of 1 & 2) | | (4) Phytoplankton biomass (June-Oct) | | (5) Zooplankton settled volume (August) | | (6) Zoobenthos all organisms (July) | | (7) Fish all species (July-Sept) | | (8) Relative production (Average of 4,5,6,7) | | (9) Area (percent of total) | (10) Percent of total lake production produced | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | | Pre | Post |
| Churchill River | 1 | 100 | 100 | 65 | 65 | 83 | 83 | 68 | 68 | 46 | 46 | 100 | 100 | 94 | 94 | 77 | 77 | 25 | 26 | 26 |
| | 2 | 96 | 96 | 70 | 70 | 83 | 83 | 76 | 76 | 83 | 83 | 36 | 36 | 100 | 100 | 74 | 74 | 12 | 12 | 12 |
| | 3 | 94 | 20 | 80 | 130 | 87 | 75 | 85 | 60 | 51 | 70 | 68 | 40 | 87 | 75 | 73 | 60 | 11 | 11 | 9 |
| | 4 | 90 | 20 | 100 | 150 | 95 | 85 | 100 | 80 | 100 | 50 | 65 | 40 | 71 | 60 | 84 | 60 | 33 | 38 | 27 |
| Local Drainage | 5 | 4 | 4 | 100 | 100 | 52 | 52 | 59 | 59 | 50 | 50 | 52 | 52 | 99 | 99 | 65 | 65 | 11 | 9 | 9 |
| | 6 | 3 | 94 | 70 | 40 | 37 | 70 | 19 | 60 | 26 | 85 | 30 | 40 | 30 | 60 | 26 | 60 | 6 | 2 | 5 |
| | 7 | - | - | - | - | - | - | - | - | 82 | 82 | 50 | 50 | 60 | 60 | 64 | 64 | 2 | 2 | 2 |
| | | | | | | | | | | | | | | | | | | | 100 | 90 |

likely to decline by 15 to 30 percent following diversion. Regions 3 and 4 will incur a reduction of from 25 to 50 percent of their crop, while region 6, will become more productive. The rest of the lake should remain essentially the same. *Pontoporeia* is an important whitefish food. Midge larvae, especially individuals of the genus *Chironomus*, are also important as whitefish food. The large populations of *Chironomus* in regions 3 and 4 and the east half of 2 will be replaced by *Tanytarsini* which are smaller and less suitable for whitefish food.

Inundation will affect water quality in all regions of the lake, but the changes will not be as drastic as those associated with diversion. Shoreline erosion will supply nutrients and sediment loading, but since the lake already is very high in nutrients, the important factor will be increased turbidity due to more suspended sediment. Thus, any advantage of more nutrients will be offset by the negative effects of greater turbidity. Where inundation occurs in areas of substantial vegetative cover, the decaying vegetation will create an oxygen demand that could result in reduced oxygen levels. These lower levels will be harmful to fish and zoobenthos.

Impoundment and diversion will cause generally lower productivity in Southern Indian Lake. Maximum declines will occur in regions 3 and 4 (Table 8-7) where some parameters will be reduced to two-thirds of their present value. In lake regions unaffected by diversion there will be decreases in production especially in the short-term while eroding shorelines increase turbidity. Overall biological productivity in the lake will drop by approximately 10 percent.

With reduction of the food base, particularly in regions 3 and 4, there will be a gradual decline in fish production. The effects of both the flooding and diversion on some of the major fish species are outlined in Table 8-8. Production of the two commercially important fish species, whitefish and walleye, will likely decline. In addition, they will likely have reduced spawning success. Northern pike, however, will show an initial positive response to impoundment. Newly flooded land will provide ideal spawning habitat for pike.

TABLE 8-8
ANTICIPATED EFFECT OF FLOODING AND DIVERSION ON PRODUCTIVITY OF PARTICULAR FISH SPECIES IN SOUTHERN INDIAN LAKE, PRIOR TO SHORELINE STABILIZATION. THE NUMBER OF SYMBOLS IS TO DENOTE RELATIVE DIFFERENCES AND IS NOT TO SUGGEST ABSOLUTE NUMBERS; THE SIGN DENOTES EXPECTED DIRECTION OF IMPACT.

| Region | Development | Anticipated Effect | Anticipated Relative Effect | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Whitefish | Walleye | Pike | Cisco | Sauger | Other |
| 1 | Flooding | Altered near-shore habitat | - | - | | - | + | - |
| | | Altered lake-spawning habitat | - | | ++ | -- | - | |
| 2 (east) | Flooding | Altered near-shore habitat | - | - | | - | + | - |
| | | Altered lake-spawning habitat | -- | | ++ | -- | - | |
| 2 (west) | Flooding | Altered near-shore habitat | - | - | | - | + | - |
| | | Altered lake-spawning habitat | -- | | ++ | -- | - | |
| | Diversion | Decreased flushing time | - | - | - | - | - | - |
| | | Disoriented migration | -- | - | | | | |
| 3 | Flooding | Altered near-shore habitat | - | - | | - | + | - |
| | | Altered lake-spawning habitat | - | ++ | | | | |
| | Diversion | Decreased primary production | -- | - | - | -- | - | -- |
| | | Increased lake habitat | ++ | + | ++ | ++ | + | + |
| 4 | Flooding | Altered near-shore habitat | - | - | | - | + | - |
| | | Altered lake-spawning habitat | --- | | ++ | - | | |
| | Diversion | Decreased primary and secondary production | -- | - | - | -- | | -- |
| | | Disoriented migration | --- | | | | | |
| 5 | Flooding | Altered near-shore habitat | - | -- | | - | + | - |
| | | Altered lake-spawning habitat | - | | ++ | -- | | |
| 6 | Flooding | Altered near-shore habitat | | -- | | - | + | - |
| | | Altered lake-spawning habitat | | | ++ | - | - | |
| | Diversion | Increased primary and secondary production | ++ | + | + | ++ | + | ++ |
| 7 | Flooding | Altered near-shore habitat | - | - | | - | + | - |
| | | Altered lake-spawning habitat | - | | + | -- | - | |

## FISHERIES

Commercial Fishery - Fishing has provided a major source of cash income to the South Indian Lake community. The commercial fishery on the lake has operated from the winter of 1941-42 until the summer of 1973. Whitefish, walleye and northern pike are the most abundant species in the lake. Whitefish, the primary commercial species, are dominant in all regions except South Bay and are in greatest abundance in regions 2, 4 and 5. "Coarse" fish species (white sucker, longnose sucker, burbot and perch) are in reasonably good supply. Region 4 accounts for 40 percent of total biological production and yields 75 percent of the total commercial catch; regions 1 and 2 account for most of the remainder.

The commercial fishery is very productive (2.5 lb/acre). The winter fishery has had an average production of 456,000 lb, 95 percent of which are whitefish. It is carried on north of Long Point, in region 4. "Break-even" requirements for operators ranged from 2400 lb using dog teams to 7500 lb using snowmobiles, with production costs ranging from 6.2 to 8.8¢/lb.

The summer fishery, operated since 1950, has produced an average annual catch of 700,000 lb, 86 percent of which are whitefish and 13 percent walleye. The entire lake is fished but regions 1, 2 and 4 produce the highest landings. Annual break-even points for operators ranged from 5263 lb (single fishermen) to 13,442 lb (paired operators employing additional labour). Unit costs of production ranged from 6.82 to 7.97¢/lb. Average gross income per fisherman has increased from $825/year during 1950-51, to $2409/year in 1972-73 (winter and summer seasons). Despite high productivity of the commercial fishery, there is no evidence of over-exploitation of the whitefish population and it appears that fishing effort, rather than fish productivity, is currently limiting the catch. Maximum sustainable yield is probably significantly in excess of the present quota.

Since 1969, South Indian Lake Co-op Fisheries Ltd has operated three stations on the lake: Camp 3, Camp 9 and Loon Narrows Camp (Fig. 8-8). In summer, fish are bought at all three stations but in winter they are only purchased at Loon Narrows.

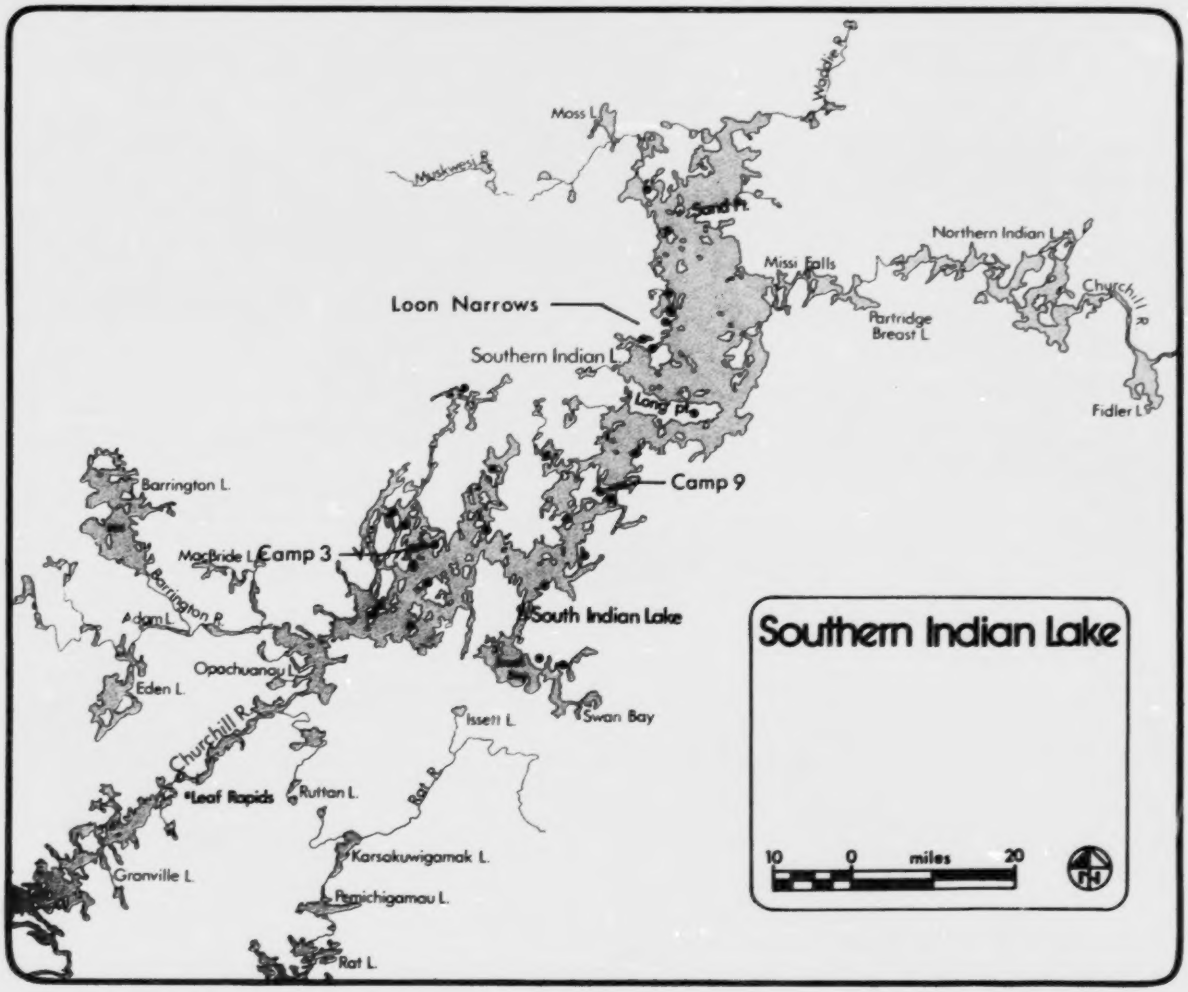

Waddie R.
Moss L.
Muskwesi R.
Sand Pt.
Northern Indian L.
Missi Falls
Churchill R.
Loon Narrows
Partridge Breast L.
Southern Indian L.
Long Pt.
Fidler L.
Camp 9
Barrington L.
MacBride L.
Camp 3
Barrington R.
Adam L.
South Indian Lake
Southern Indian Lake
Opachuanau L.
Eden L.
Issett L.
Swan Bay
Churchill R.
Rat R.
Leaf Rapids
Ruttan L.
Karsakuwigamak L.
Pemichigamau L.
Granville L.
Rat L.
10
0
miles
20

Fig. 8-8. The Location of Past and Present Fish Camps on Southern Indian Lake.

The Co-op has acted as the sole buyer on the lake as agent for the sole marketing agency, the Freshwater Fish Marketing Corporation, a federal government Crown Corporation.

As with all northern fisheries, the most critical problem is getting the fish to market in good condition; this has hindered the economic success of the fishery. Until 1972 all fish caught during the summer were flown to the railhead at Lynn Lake. With completion of the Lynn Lake to Leaf Rapids road (Provincial Road 391) transportation costs were lowered because fish could be transported to Leaf Rapids by boat in summer and by snowmobile or aircraft in winter, and from Leaf Rapids to Lynn Lake by semi-trailer truck, both summer and winter. The road from Thompson to Leaf Rapids (Provincial Road 391) provides even more direct transportation links with southern markets.

Each licensed fisherman is permitted 1500 yards of gill-nets of 5 1/4 inch stretch mesh. In summer, nets are set from open boats, commonly 19-ft wooden yawls, powered by two, 20 to 25 hp outboard motors. The season opens on June 1 and fishermen operate either at Opachuanau Lake or Camp 3. They move to Camp 9 (about July 1) and then to Loon Narrows. The Loon Narrows camp usually produces the most fish. From mid-June to the end of the season on October 15 fishermen deliver their catches to Loon Narrows.

Gill-nets are easily relocated during summer and fishermen are less tolerant of low catch per unit of effort. Once nets are set they remain in one location sometimes for weeks until catches drop off. The major whitefish fishing grounds are usually in water of 50 to 70 ft in depth.

Winter fishing is done out of Loon Narrows between mid-January and mid-April. Effort is concentrated in three areas: north of Loon Narrows near Duck Narrows, near Jam Island east of Loon Narrows, and south of Long Point. Setting gill-nets under ice is time consuming and nets are seldom moved once set. During the winter, fishermen would rather tolerate low catch per unit effort than move nets.

Winter Fishery - Production in the winter fishery has varied considerably (Fig. 8-9). Average production per season for the 30 years of the winter fishery to 1971-72, has been 455,626 lb. Whitefish accounts for an average 95.4 percent of the landings, yellow walleye for 3.9 percent and pike, 0.7 percent (Table 8-9). In the past 6 years, winter production has declined to an average of 335,434 lb/year due to adverse social and economic factors. During the 1971-72 winter season, the quota was decreased from 600,000 lb to 400,000 lb. Average value per licence

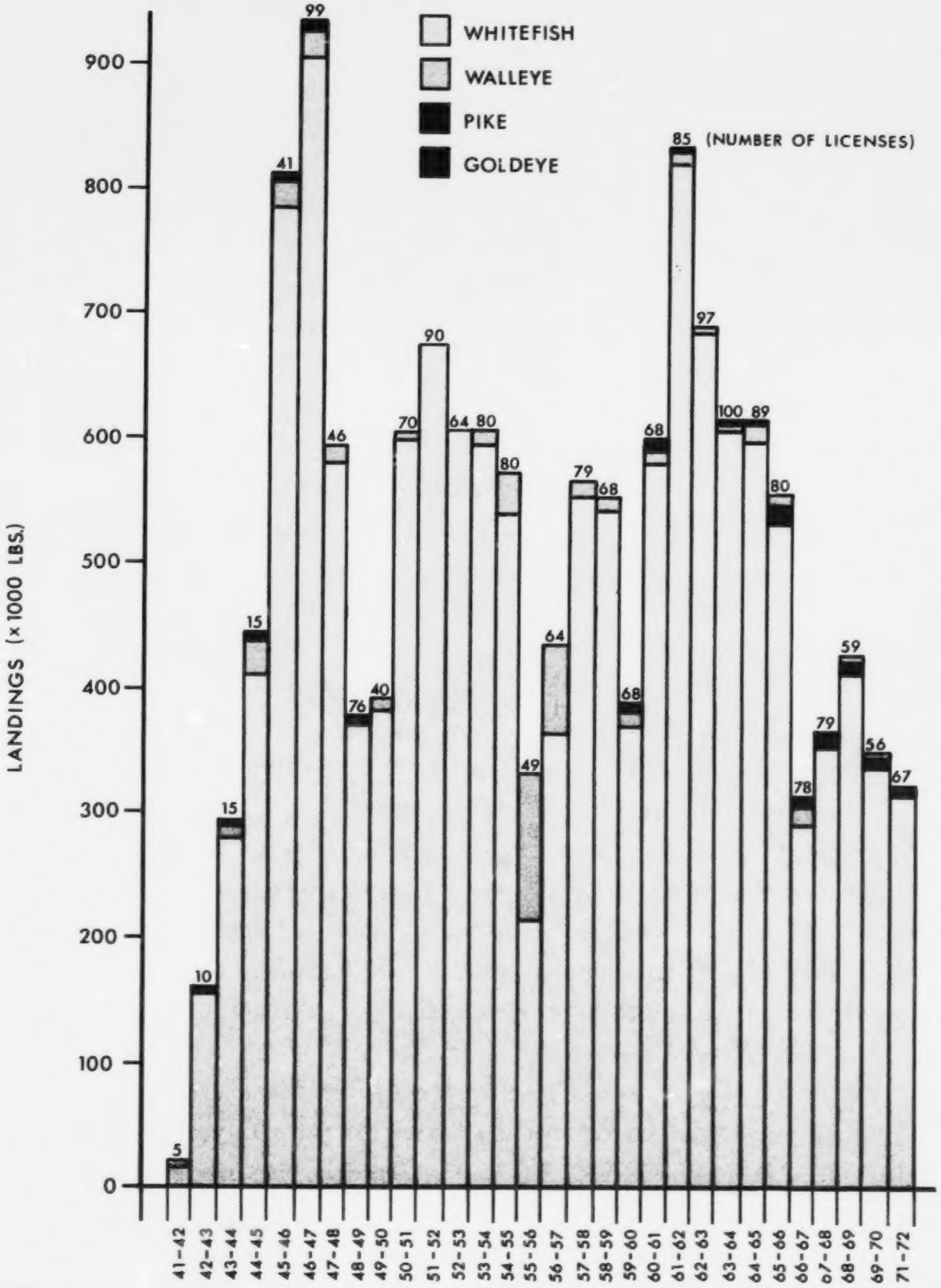


Fig. 8-9. Total Landings by Species for the Winter Fishery (1941-42 to 1971-72).

TABLE 8-9
THE AVERAGE LANDINGS PER WINTER SEASON, AVERAGE LANDINGS PER LICENCE, AVERAGE PERCENT WHITEFISH AND AVERAGE PERCENT WALLEYE IN LANDINGS FOR 5 YEAR PERIODS BEGINNING IN THE 1941-42 SEASON.

| Seasons | Average landings per season (pounds) | Average landings per season per licence (pounds) | Percent of Whitefish | Percent of Walleye |
|---|---|---|---|---|
| 1941-42 to 1945-46 | 199,120 | 29,566 | 95.9 | 3.1 |
| 1946-47 to 1950-51 | 507,920 | 9,147 | 97.2 | 2.6 |
| 1951-52 to 1955-56 | 544,680 | 7,640 | 89.5 | 10.5 |
| 1956-57 to 1960-61 | 503,140 | 7,237 | 94.6 | 5.1 |
| 1961-62 to 1965-66 | 657,540 | 7,403 | 98.3 | 0.9 |
| 1966-67 to 1970-71 | 347,320 | 5,253 | 97.0 | 1.4 |
| 1971-72 | 276,000 | 5,307 | 98.9 | 0.5 |
| Average for all years | 455,626 | 10,856 | 95.5 | 3.8 |

for the winter fishery (regarded as the fisherman's average gross income for the season) has increased from $507 during 1946-51 to $1,133 during 1966-71 (Table 8-10 and Fig. 8-10). The fact that production has not reached the quota in recent years is probably due to the price of fish in winter (about 4¢/lb lower than summer because of increased shipping costs), lack of participation, and problems in maintaining transportation equipment, rather than an actual reduction in fish stocks.

TABLE 8-10
AVERAGE VALUE TO THE FISHERMEN, AVERAGE NUMBER OF LICENCES AND AVERAGE VALUE PER LICENCE FOR THE PAST 31 YEARS OF THE WINTER COMMERCIAL FISHING ON SOUTHERN INDIAN LAKE

| Seasons | Average Value | Average number of Licences | Average Value per Licence |
|---|---|---|---|
| 1941-42 to 1945-46 | $ 26,064 | 17 | $1,339 |
| 1946-47 to 1950-51 | 32,820 | 66 | 507 |
| 1951-52 to 1955-56 | 39,143 | 73 | 559 |
| 1956-57 to 1960-61 | 47,756 | 69 | 697 |
| 1961-62 to 1965-66 | 116,034 | 90 | 1,298 |
| 1966-67 to 1970-71 | 75,592 | 68 | 1,133 |
| 1971-72 | 33,439 | 52 | 643 |
| Average for period | 55,499 | 63 | 913 |

*Source: Manitoba Dept. of Mines, Resources and Environmental Management*

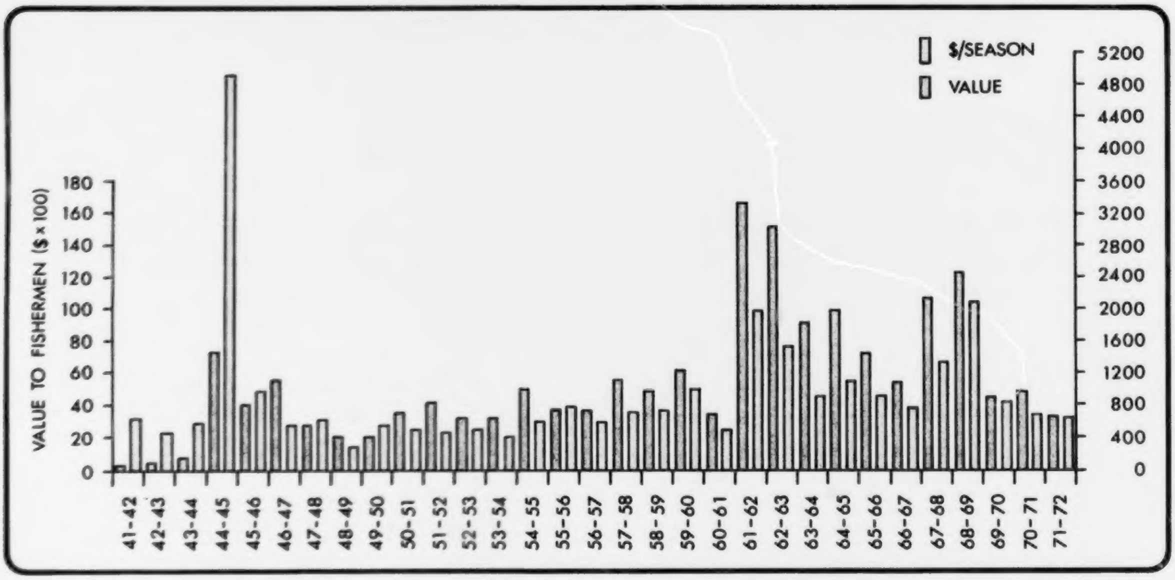


Fig. 8-10. Total Value to the Fishermen and Average Value per License for the Winter Seasons on Southern Indian Lake from 1941-42 to 1971-72.

Summer Fishery - Production has increased steadily (Fig. 8-11 and Tables 8-11 and 8-12). In the 1973 summer season 725,000 lb were produced. The quota has been repeatedly increased to the present 800,000 lb. The summer fishery has been very successful. Fish are plentiful and easily caught and production has steadily risen. Both production and fish prices increased substantially between 1950 and 1972, leading to an increase in value to fishermen from $9,790 in 1950 to $149,807 in 1972. The steady increase in summer production has been accompanied by a decrease in number of fishermen. The result has been a substantial increase in average production per licence. The trend in recent years has been increased summer production and decreased winter production. Summer production, however, is still below the quota, but as in the winter fishery this situation is related to effort, not fish abundance.

Production Potential - On the basis of past information, Southern Indian Lake, in its natural state, can support a sustained yield for the winter fishery of at least 400,000 lb of whitefish and walleye. If the less valuable species such as burbot, suckers, pike and cisco are fished, sustained yield will be higher. If production cannot exceed the quota of 400,000 lb, then the value of the fishery will be primarily dependent on the pricing system, transportation costs, and

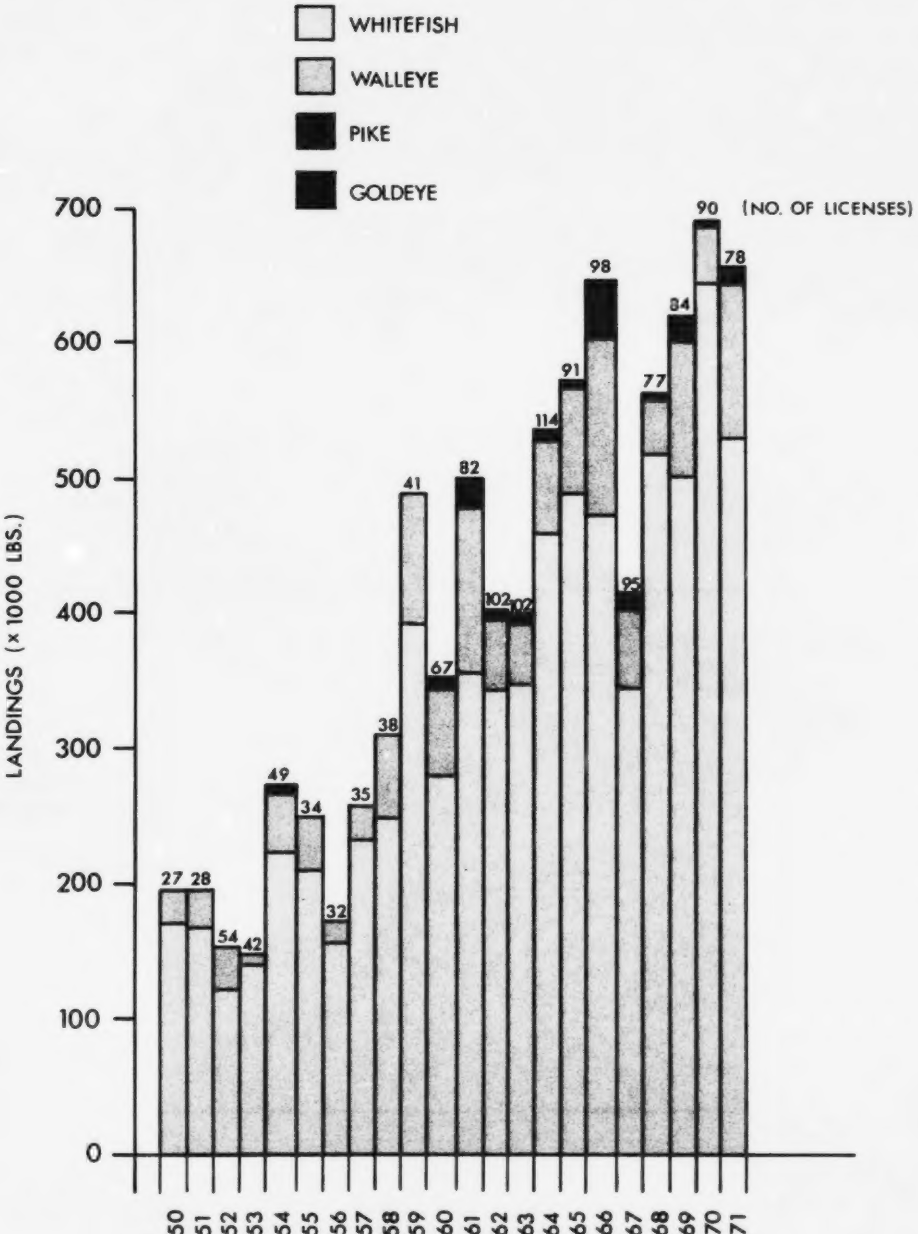


Fig. 8-11. Total Landings by Species for the Summer Seasons on Southern Indian Lake from 1950 to 1971.

TABLE 8-11
AVERAGE VALUE PER SEASON, AVERAGE INCOME PER SEASON PER FISHERMEN AND THE AVERAGE NUMBER OF LICENCES PER SEASON FOR THE SUMMER FISHERY FROM 1950 TO PRESENT, AVERAGED OVER 5 YEAR PERIODS.

| Seasons | Average value per season | Average Income | Average number of licences |
|---|---|---|---|
| 1950-51 | $ 8,926 | $ 325 | 28 |
| 1952-56 | 11,706 | 323 | 41 |
| 1957-61 | 27,363 | 499 | 62 |
| 1962-66 | 59,496 | 599 | 100 |
| 1967-71 | 81,193 | 986 | 82 |
| 1972 | 149,807 | 2,880 | 52 |
| Average for all seasons | $ 56,415 | $ 935 | 61 |

TABLE 8-12
THE AVERAGE LANDINGS PER SUMMER, AVERAGE LANDINGS PER SEASON PER LICENCES, PERCENT WHITEFISH AND PERCENT WALLEYE IN CATCH FOR THE SUMMER SEASONS ON SOUTHERN INDIAN LAKE GROUPED IN 5 YEAR PERIODS.

| Seasons | Average landings per seasons (pounds) | Average landings per licence per season (pounds) | Percent of Whitefish | Percent of Walleye |
|---|---|---|---|---|
| 1950-51 | 195,150 | 7,098 | 87 | 13 |
| 1952-56 | 200,740 | 5,351 | 86 | 14 |
| 1957-61 | 379,340 | 6,408 | 80 | 19 |
| 1962-66 | 506,380 | 5,138 | 82 | 15 |
| 1967-71 | 585,420 | 7,139 | 89 | 10 |
| 1972 | 712,900 | 13,709 | 91 | 6 |
| Average for all seasons | 429,988 | 7,473 | 86 | 13 |

marketing and product trends. If a market can develop for the less desirable species, value could increase substantially; if not, value will only increase as the demand for fish increases.

The available evidence indicates that the lake in its natural condition can support a sustained yield of at least 800,000 lb for the summer fishery.

Domestic Fishery - It has been estimated that $36,400 was provided in income in kind in 1972 by the domestic fishery. This was based on the assumption that each family consumed the equivalent of four meals of fish per week per family. Each meal was assumed to be worth $2.50. On this basis, the seventy families of South Indian Lake consumed four meals per week, fifty-two weeks of the year, at $2.50 per meal or the equivalent of $36,400. The fish are shared amongst the members of the community and as a result all residents benefit from the supply of fish for domestic use.

Sport Fishery - Cost of northern travel (usually air charter) has limited sport fishing. With increased northern development, roads are gradually making areas available for sport fishing. There is no sport fishing lodge on Southern Indian Lake or Opachuanau Lake. Sport fishing is limited to an area of the Churchill River near Leaf Rapids where fishing pressure comes from the new community of Leaf Rapids, the Barrington River in the vicinity of a summer cottage and in the rest of the lake to the few tourists who visit. None of the residents of Southern Indian Lake participate in sport fishing.

There is a very high potential for trophy northern pike fishing on Southern Indian and Opachuanau lakes. Pike production is excellent and good habitat is readily available in all parts of the lake. Pike are not only large but very numerous which is also attractive to sport fishermen.

Potential of the walleye sport fishery is limited by remoteness of many of the better areas and small size of the fish. Although walleye may not constitute the main reason to sport fish in the area, they offer an attractive alternative to pike.

EFFECT ON FISHERIES - Production of northern pike should increase following impoundment and diversion. Although pike are not commercially desirable at present, being only incidental to commercial and domestic catches, this might not always be the case. Sauger are reasonably abundant only in regions 1 and 6 and it is doubtful that commercially valuable populations will be established following diversion.

White sucker are present in most areas while longnose sucker are more prevalent in the main lake regions. Probably neither species will be adversely affected by flooding and diversion. Present transportation costs preclude Southern Indian Lake as a source for longnose suckers. However, as the economic value of this and other coarse species increases, transportation costs will become less of a factor, and these fish will become more important commercially.

Because of the effects of the diversion on the biological productivity of the lake, populations of whitefish and walleye will likely decline in regions 3 and 4, while populations of whitefish will increase in region 6 (relative to present levels). However, impact would be much more drastic if the lake were subjected to the minimum allowable discharges at Missi Falls for an extended time. Populations would be reduced even further in regions 3 and 4 and the commercial fishery would be severely affected. Overall impact of the diversion and flooding on the abundance of commercial species will result in the stabilization of whitefish and walleye at population densities lower than those which exist at present.

Effect on Commercial Fishery - Commercial fishing will become more difficult following impoundment. Until fishermen have learned the locations of debris-free areas, loss of nets could be high and even with clearings for boat landings at regular intervals and at fish camps, transportation for fishermen on the lake will involve more risk; commercial fishing will become less economic. Even if these problems are surmounted, a decline in the commercial fishery can be expected. The location of present fishing grounds closely match the areas of high biological productivity, and the choice of fishing sites by fishermen is determined by their success (catch per unit effort). In future many of the presently more productive areas will have substantial reductions in their potential. If fishermen maintain their present level of effort in the same areas now fished their yield will decline. This is summarized in Table 8-13, where it is assumed that commercial yields of whitefish and walleye will decline in proportion to biological productivity in regions 3 and 4. Even if region 6 makes substantial gains in productivity and potential yield after diversion, its smaller area makes it impossible for these gains to offset the losses in region 4. Because the present commercial fishery is concentrated in region 4, the region of maximum impact, the percentage decline in the commercial fishery will be greater than the overall decline in biological productivity.

The decline in yield could be offset if the total effort applied to the fishery increased, i.e., decline in catch per unit effort can be offset by more effort. There is no evidence of over-exploitation by commercial fishermen now, and it is not likely that increased effort would adversely affect the fishery. The need for increased effort will probably result in marginal operators becoming discouraged and leaving the fishery. This human element is likely to amplify the decline in the commercial yield as total effort also declines. This is especially true in the short-term when catch per unit effort will suffer while fishermen attempt to locate concentrations of fish under the new regime. The fishery may never again reach its present level unless the economics of the market change markedly.

TABLE 8-13
COMMERCIAL YIELD (IN POUNDS) OF WHITEFISH AND WALLEYE FROM DIFFERENT REGIONS OF SOUTHERN INDIAN LAKE (BEFORE) WITH AN ESTIMATE OF COMMERCIAL YIELD OF THESE SPECIES FROM THE SAME REGIONS FOLLOWING DIVERSION AND IMPOUNDMENT (AFTER). VALUES GIVEN FOR THE BEFORE CONDITIONS ARE BASED ON THE RESULTS OF THE 1972-73 WINTER FISHERY AND THE 1973 SUMMER FISHERY.

| Region | | Whitefish | | | Walleye | | | Total Yield | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | area (acres) | before (lb) | after (lb) | percent change (approx) | before (lb) | after (lb) | percent change (approx) | before (lb) | after | percent change (approx) |
| 1<br>2<br>3<br>7 | 233,000 | 220,000 | 210,000 | -5 | 33,000 | 31,500 | -5 | 253,000 | 241,500 | -5 |
| 4 | 155,000 | 680,000 | 540,000 | -20 | 70,000 | 56,000 | -20 | 750,000 | 596,000 | -20 |
| 5* | | | | | | | | | | |
| 6* | 29,000 | * | 35,000 | ** | 5,000 | 5,500 | +10 | 5,000 | 40,500 | +800 |
| Total | 417,000 | 900,000 | 785,000 | -13 | 108,000 | 93,000 | -14 | 1,008,000 | 878,000 | -13 |

* Regions 5 and 6 are not fished except for walleye (region 6).

** Percent change cannot be derived as commercial yield (before) is not available.

Effect of Reduced Mobility on Fish Exploitation - In areas with substantial vegetative cover, inundation could pose problems. Region 5 has extensive treed muskeg along the lower reaches of the Waddie and Muskwesi rivers which will be inundated as a result of the lake level being raised. Organic materials from these areas present the threat of floating debris (floating islands) to fishing and navigation. Although debris will be produced from all new shorelines, the shorelines of this region have the greatest potential for producing floating organic debris. The floating islands can be transported great distances, can be hazardous for navigation and can disrupt the activities of commercial fishermen. Since water exchange between region 5 and the main lake will be poor, much of the debris will accumulate and settle within the region. Severity of impact on region 5 would be of even greater concern if the region were being used by the commercial fishery, as the organic debris would be a serious problem to net handling and navigation. Unless the Sand Point channel is boomed, the potential entry of floating debris will present a hazard to fishing operations in region 4, the main fishing area.

Effect on Sport Fishery - Southern Indian Lake has the potential to support an excellent trophy pike sport fishery. Impoundment will have a positive effect on northern pike, with initial increases anticipated in size, condition and number both for sport and commercial fishing. Although no trophy sized walleye have been captured, sport fishing for walleye is also considered to be above average.

The road system developed in connection with the diversion project will assist in realization of the full potential of the sport fishery on Southern Indian Lake and Opachuanau Lake. If a sport fishery is to be promoted and developed, small craft landing sites and boat ramps should be constructed in the Leaf Rapids area.

## WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE

Shoreline habitat is important to most birds and mammals. The nature of shorelines determines the degree of importance. Long, uninterrupted stretches of steep, exposed bedrock shoreline with little or no fringe of emergent vegetation attract few wildlife species, while wide bands of permanent marshes growing on rich mineral soil generally support a greater number. Similarly, thin peat or muck with good growth of emergent plants such as bulrush (*Scirpus* sp.), cattail (*Typha* sp.) or sedge (*Carex* sp.) and abundant submerged plants, such as pondweeds (*Potamogeton* spp.) attract waterfowl and muskrats. Gently sloping beaches with willow and sedge provide food and cover for some species of nesting waterfowl, numerous passerine birds, and mammals such as mink and moose. General wildlife relationships with shoreline types as defined by the Physical Impact Study are outlined in Table 8-14. As described in the physical effects section, the raising of the levels on Southern Indian Lake will alter the shape of shorelines and the plant species along them. Changes in the physical environment will affect wildlife populations in the Southern Indian Lake area.

### WILDLIFE HABITAT AND POPULATIONS

Ungulates - Low numbers of moose (*Alces alces*) in the Southern Indian Lake area can be attributed to habitat having moderate to moderately severe limitations to moose production and severe environmental conditions. Moose primarily use young deciduous or mixed-wood stands found along low shorelines and in early successional stages of burned over areas. Water lilies (*Nuphar* sp.) and pondweeds are eaten when available. The best moose habitat in the area is found at the northern end of the lake, around South Bay and from Opachuanau Lake to Leaf Rapids.

TABLE 8-14
SOUTHERN INDIAN LAKE SHORELINE TYPES AND ASSOCIATED WILDLIFE

| SHORELINE TYPE | WILDLIFE USE | | | |
|---|---|---|---|---|
| | Mammals | | Birds | |
| Steep bedrock (Type 11) | Mink | D,F | Waterfowl | -some diving ducks, especially mergansers, F,R,M. |
| | | | Passerines | -warblers, sparrows, B,F,M. |
| Low bedrock (Type 13) | Bear | F,T | Waterfowl | -diving ducks, occasional dabblers in marsh, F,R,M. |
| | Lynx | F,T | | |
| | Mink | B,D,F | Marshbirds | -grebes, F,M. |
| | Moose | F,T | Larids | -gulls and terns on islands,B,F,R. |
| | Hares | F,T | Shorebirds | -spotted sandpiper, B,F,M. |
| | | | Passerines | -warblers, sparrows, B.F,M. |
| | | | Raptors | -eagles, R,F. |
| Bedrock-controlled (Beach may be present) (Types 14 & 15) | Mink | B,D,F,T | Waterfowl | -most dabblers and divers where marsh developed, B,F,R,M. |
| | Lynx | F,T | | |
| | Bear | F,T | Marsh birds | -grebes, B,F,R,M. |
| | Moose | F,T | Larids | -Caspian terns on beach. |
| | Fox, Wolf | F,T | Shorebirds | -occasional use. |
| | Hares | B,F,T | Passerines | -flycatchers, warblers, juncos, rusty blackbird. |
| | | | Raptors | -hawks, owls, B,F. |
| Medium steep slope in sediments (Types 22 & 23) | Mink | B,F,T | Waterfowl | -most dabblers and divers where marsh developed, B,F,R,M. |
| | Lynx | F,T | | |
| | Beaver | Minimal | Marsh birds | -grebes, B,F,R,M. |
| | Muskrat | Minimal | Shorebirds | -favourable to most, B,F,R,M. |
| | Bear | F,T | Passerines | -chickadees, juncos, warblers, sparrows, B,F,M. |
| | Moose | F | | |
| | Fox, Wolf | F,T | | |
| | Hares | B,F | | |
| Low shoreline (Types 24,26-28) | Mink | F,T | Waterfowl | -geese and most dabblers and divers, B,F,M. |
| | Lynx | F,T | | |
| | Otter | F | Marsh birds | -rails, soras, snipe, B,F,M. |
| | Beaver | F | Shorebirds | -favourable to many |
| | Muskrat | B,F | Passerines | -thrushes, warblers, swamp sparrow. |
| | Bear | F,T | | |
| | Moose | F | | |
| | Fox, Wolf | F,T | | |
| | Hares | F | | |
| Floating fen (Type 31) | Little mammal use | | Waterfowl | -Canada goose, B,F,R, some dabblers and divers, B.F. |
| | | | Passerines | -swamp sparrow, Traill's flycatcher, yellow warbler. |

*Legend* - *B-breeding, F-feeding, R-resting, D-denning, M-migrating, T-travelling.*

One segment of the barren-ground caribou (*Rangifer tarandus*) population intermittently migrates past the northern end of Southern Indian Lake on the way from the eastern Northwest Territories to Reindeer Lake, Manitoba. Migration patterns have changed with declining population since the 1950's, and herds have not recently wintered near the South Indian Lake community as they did in times of higher numbers. Barren-ground caribou eat lichens and some perennial plants and shrubs during winter. Some areas of potential caribou winter range occur near northern sections of the lake which may be used occasionally during migration.

Furbearers - In terms of both economic value and numbers, the major species in the area are beaver (*Castor canadensis*), lynx (*Lynx canadensis*), mink (*Mustela vison*) and muskrat (*Ondatra zibethicus*). Other furbearers in the area include otter (*Lutra canadensis*), fox (*Vulpes* spp.), pine marten (*Martes americana*), red squirrel (*Tamiasciurus hudsonicus*), wolf (*Canis lupus*) and wolverine (*Gulo luscus*).

Beaver utilize areas of deciduous growth near streams and creeks, and shoreline type has little direct relation to distribution of this animal in the area. Poplar (*Populus* spp.) and willow (*Salix* spp.) are preferred for food and building material, but poplar is at the northern extreme of its range in the northern third of the lake. The best habitat for beaver is the area south of Long Point.

Lynx utilize all forest types but are more common near the southern part of the lake. There is little dependence on lake shorelines.

Mink are semi-aquatic and prefer low bedrock, medium-steep sediment and low shorelines which have good deciduous growth. Nearly the entire shoreline of Southern Indian Lake is suitable habitat for mink. They eat small mammals, especially muskrats, in winter and shellfish, birds and insects in summer.

Muskrats prefer reed-swamp or marsh areas with rooted aquatic vegetation. Prime food sources are scouring rush (*Equisetum* sp.), bulrush and pondweed. Muskrat distribution is directly related to marsh habitat.

Birds - The avifauna of this area is typical of the western subarctic shield region except for the occurrence of several southern wetland waterfowl species at the northern extremeties of their range, and two other species breeding north of their previously recorded range.

Waterfowl - Sixteen species of waterfowl were observed on Southern Indian Lake during 1973. Waterfowl use the lake for migration rest stops, staging, and breeding. The lake offers some nesting habitat to the Canada goose (*Branta canadensis*) and a limited number probably nest on the small ponds and marshy areas around Southern Indian Lake.

The mallard (*Anas platyrhynchos*) and the American widgeon (*Mareca americana*) are the most common dabbling ducks breeding in the area. Mallards utilize protected vegetation to feed and breed. They are generally associated with marshes in the northern third of the lake. American widgeon are common near Missi Falls and on the northwest section of the lake. They nest near the shore eating plants and invertebrates.

Commonly breeding diving ducks in the area include the common goldeneye (*Bucephala clangula*) and the lesser scaup (*Aythya affinis*). Two species of merganser (*Mergus* spp.) probably also breed on Southern Indian Lake. The common goldeneye builds its nest in trees in bogs and swamps. Mergansers feed on fish and are common along the rocky shores near Missi Falls and in muskeg areas. In addition, the common goldeneye, lesser scaup and mergansers use the area for staging, particularly the Muskwesi-Waddie area.

Whistling swans (*Olor columbianus*) are common on the Churchill River during the fall and apparently use Southern Indian Lake to a limited degree for spring staging. The common loon (*Gavia immer*) utilizes sheltered sites in emergent vegetation around islands and along rocky shorelines for breeding. They eat fish and are most common around Missi Falls.

Colonial Nesting Birds (Larids) - Three species of gulls and two species of terns were observed in the area. Herring gulls (*Larus argentatus*) and ring-billed gulls (*Larus delawarensis*) are common colonial breeders. Common terns (*Sterna hirundo*) and Caspian terns (*Hydroprogne caspia*) are also found nesting in colonies (Fig. 8-12). At least ten colonies occur on the lake, and all are a minimum of several hundred yards from the lake shoreline on small, rocky islands with sparse vegetation.

Evidence of breeding by Caspian terns on Southern Indian Lake represents a northerly extension of their known breeding range.

Other Birds - Bald eagles (*Haliacetus leucocephalus*) and ospreys (*Pandion haliaetus*) are considered rare and endangered species in Manitoba. Bald eagles are commonly seen along the shores of Southern Indian Lake. These fish-eating birds nest in trees near the shore. Hawks and owls also occur and are found in willow and mixed-woodland where they prey on small birds and mammals.

A rich variety of passerines inhabit the wetlands and forested uplands of Southern Indian Lake. Most common are yellow (*Dendroica petechia*), Tennessee (*Vermivora peregrina*) and Myrtle warblers (*Dendroica coronata*), and song (*Melospiza* *melodia*) and chipping sparrows (*Spizella passerina*). Red-winged blackbirds (*Agelaius phoeniceus*) breed in marshes of the lake, a northerly extension of their previously known breeding range.

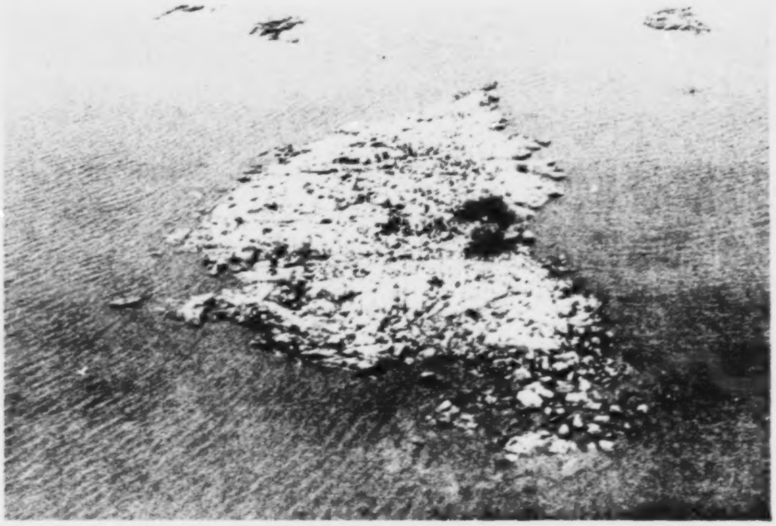


Fig. 8-12. Gull Nesting Colony on Southern Indian Lake, 1973.

EFFECT ON WILDLIFE HABITAT AND POPULATIONS - In general, the diversion of Churchill River flows is expected to reduce moose and furbearer habitat through flooding and some declines in base populations are predicted. Some loss of waterfowl breeding and staging habitat is expected along with complete loss of known colonial bird nesting islands.

Effect on Ungulates - Flooding of browse and aquatic vegetation along shorelines will eliminate some feeding areas for moose. Carrying capacity of the area will be reduced until willow and other browse species reestablish on shorelines. Assuming potential winter density between 0.25 and 0.5 moose per square mile of flooded area (173 square miles), loss of habitat for forty-six to ninety-two moose will occur.

Barren-ground caribou are probably not dependent on the lake shorelines for food. Flooding will have little effect on caribou range or movements. Some sedge communities, potential winter forage, will be lost, but large expanses of open black spruce forest and muskeg occur outside the flooded area.

With increased access to the area, a potential exists for disturbances of barren-ground caribou should the migration extend further southward. Some harassment around construction and maintenance camps and future recreation areas could occur but would be minimal because of the possible presence of caribou in winter only. Forest fires destroy caribou winter range and a higher forest fire threat is inevitable with increased recreation use of Southern Indian Lake in summer.

Secure ice conditions are necessary for mobility of ungulates. Significant changes in water levels during winter could affect caribou crossing the lake but under the proposed regulation scheme ice conditions should remain stable over most of the lake.

Effect on Furbearers - Furbearers will be directly affected by inundation of habitat. Beaver will be affected by loss of food and building material along creeks which will be flooded. Loss of marshes, especially in the north and south-eastern areas, will cause a decline in muskrat populations. Mink, dependent on shorelines for food and shelter will be displaced from the inundated areas. Lynx will be affected indirectly through the effect of flooding on prey species. Some other furbearers in the area may suffer similar loss of food supply and habitat. Length of time of reestablishment of suitable furbearer habitat is dependent on shoreline type, but may take several decades in some areas.

Effect on Birds - In general, flooding of the willow-sedge-beach habitat on Southern Indian Lake will bring changes in numbers and species of birds which frequent the area. Occurrence and abundance of many species will depend on reestablishment of suitable habitat after flooding.

Effect on Waterfowl - Flooding will render most of the area unsuitable to breeding waterfowl for several years, until shorelines and marshes become reestablished. Those species of ducks which prefer dense beds of emergents or low willow-covered shoreline for nesting will find few suitable sites after inundation. Value as a breeding area to both dabbling and diving ducks will decrease as the amount and quality of nesting habitat decreases. Production from an estimated 500 pairs of dabbling ducks, mostly mallards and widgeon, will be lost in northern lake sections alone. Flooded timber can be highly productive of dabbling ducks although predation by mammals can severely limit nesting success. Loons will also have fewer nesting sites for several years until emergent vegetation develops in the secluded areas this species prefers. Tree-nesting species such as common goldeneye will benefit from the flooding, as more nest sites will be available. Many of these birds typically nest in small bogs removed from the lake.

There will be little food available to ducklings and adult ducks when marshes are flooded. Lower production of aquatic vegetation and associated invertebrates due to inundation will limit populations. Until grasses and sedges become established along new shorelines, the lake will be less attractive to ducks and unattractive to Canada geese as a source of food.

The importance of Southern Indian Lake to staging waterfowl after flooding will vary a great deal among species. Fish-eating birds such as mergansers and loons will not be greatly affected. Dabbling ducks (mallards and widgeons) will find most of their former feeding sites beyond reach. Swans are also dabblers and although their range of diving depth is greater, the roots and tubers they seek in shallow water will not be there until vegetation becomes reestablished after flooding. Diving ducks such as scaup and goldeneye will be less affected during staging periods as they prefer more open water than dabblers.

With the difference in flow patterns, the only areas open to spring migrants will be in the areas around the community and in South Bay. The traditional sites around Missi Falls may remain frozen longer with the reduced flow through the control structure.

Effect on Colonial Nesting Birds - All of the nesting islands presently used by gulls and terns will be completely inundated after diversion of flows from the Churchill River. Some may disperse to other lakes but most will probably not find suitable nesting sites.

Effect on Other Birds - Fish-eating birds, eagles and ospreys, may lose some of their traditional resting and feeding areas, but generally the lake will offer suitable habitat. Hawks and owls may not find the variety of small birds and mammals that presently abound along willow and mixed-wood shores. Species abundance may change and some of these raptors may move to more attractive areas.

Passerines will suffer a reduction in habitat. Marsh dwelling species will find no emergents to nest in for several years. Where flooding has killed the productive deciduous zone, value to upland bird species will be reduced.

## WILDLIFE USE

Hunting - Moose are harvested mainly by natives from South Indian Lake to provide meat and hides. They are shot by fishermen, fall hunting parties and trappers along trails and waterways throughout summer, fall and winter. Annual harvest by community residents has been estimated at between fifteen to fifty moose. Favoured hunting areas have been around Uhlman Lake, Poplar Narrows and the Waddie and Muskwesi River areas.

The Southern Indian Lake area lies within provincial Game Hunting Area 1. In the 1972-73 hunting season there was an estimated sport hunter harvest of seventy-three (±84 percent) moose for Area 1 or 2.7 percent of the provincial kill. The area harvest is therefore a small fraction of the provincial harvest. Sport hunting is restricted by limited transportation. The area is accessible by boat from Leaf Rapids but long distances discourage recreational hunters from going beyond Opachuanau Lake.

Utilization of caribou by natives in the area has been opportunistic, and largely limited to years when caribou migrated to wintering grounds near the South Indian Lake community. Harvests provided meat and hides. The Muskwesi-Waddie, Missi Falls, and Long Point lake sections constitute potential caribou winter range of moderate quality while southern sections of the lake are less suitable. Bands of adult male caribou which may migrate to areas south of the main wintering grounds represent a potential harvest to natives not currently realized. Sport hunting of caribou is not permitted.

Duck and goose kills by licensed hunters are negligible. Major hunting pressure on waterfowl comes from natives. It has been estimated that waterfowl provide a total of 1400 to 1500 meals per year for members of the South Indian Lake community. About 1000 ducks and geese would have to be shot to supply this quantity of food. Hunting of ducks and geese is opportunistic and occurs in areas close to the community or fish camps during peak waterfowl periods in the spring and fall.

Trapping - Furbearers in northern Manitoba are harvested under a registered trapline system. Registered traplines are assigned to individuals who often retain helpers during the trapping season. The trapping season extends from late October until May. Trapping of individual species occurs during periods of the year when pelts are prime, e.g., muskrats, spring and fall; mink, early winter; lynx, midwinter.

Trapping blocks near communites are utilized to a greater extent than remote blocks. Fish camps and cabins are used as bases by trappers working remote trapping blocks, such as those in the Muskwesi-Waddie area. A community trapline near South Indian Lake is used by residents who do not have their own trapline. It also serves a recreational function. Most furbearers in the area appear to be underutilized especially in remote trapping blocks. Travel difficulties and lack of trapper motivation depress harvest.

The value of the fur harvest has declined in recent years from $46,010 in 1968-69 to $29,098 in 1971-72. There is some correlation between trapper activity and total annual return (Table 8-15). The fur resource at present represents 4 percent of community income (2 percent from fur sales and 2 percent as income in kind). Provincial government programs are being developed to increase utilization of the resource through more intensive management practices and trapper education.

TABLE 8-15
SOUTHERN INDIAN LAKE REGISTERED TRAPLINE SECTION
TRENDS IN FUR HARVEST VALUES 1967-68 TO 1971-72

| YEAR | NUMBER OF ACTIVE BLOCKS[1] | NUMBER OF ACTIVE TRAPPERS[2] | NUMBER OF PELTS HARVESTED | VALUE[3] (ALL SPECIES) | AVERAGE RETURN PER ACTIVE BLOCK |
|---|---|---|---|---|---|
| 1967-68 | 31 | 64 | 5,865 | $40,997 | $1,322 |
| 1968-69 | 38 | 90 | 4,559 | 46,010 | 1,210 |
| 1969-70 | 42 | 87 | 3,493 | 37,339 | 889 |
| 1970-71 | 43 | 91 | 3,954 | 32,770 | 762 |
| 1971-72 | 39 | 77 | 2,412 | 29,098 | 746 |
| AVERAGE | 38 | 82 | 4,056 | $37,242 | $ 985 |

[1] *Pelts harvested on trapping blocks.*

[2] *Minimum of one pelt harvested.*

[3] *Calculated using prices at current year auction sales.*

SOURCE: *Manitoba Dept. of Mines, Resources and Environmental Management fur dealer returns, The Pas.*

Beaver provide 55 percent of the annual harvest value to trappers in the Southern Indian Lake trapline section (Table 8-16). Lynx, mink and muskrat comprise 36 percent of the value while other species make up the remaining 9 percent.

TABLE 8-16
SOUTHERN INDIAN LAKE REGISTERED TRAPLINE SECTION
TRENDS IN SPECIES FUR HARVEST VALUES, 1967-68 TO 1971-72

| YEAR | SPECIES | | | | | |
|---|---|---|---|---|---|---|
| | BEAVER | MUSKRAT | MINK | LYNX | OTHER | TOTAL |
| 1967-68 | $24,498 | $3,993 | $ 7,904 | $1,829 | $2,612 | $40,997 |
| 1968-69 | 26,114 | 4,174 | 10,030 | 3,649 | 2,993 | 46,010 |
| 1969-70 | 19,190 | 2,726 | 4,537 | 7,620 | 3,106 | 37,339 |
| 1970-71 | 20,064 | 3,392 | 2,251 | 4,956 | 2,050 | 32,770 |
| 1971-72 | 13,580 | 2,753 | 2,106 | 7,311 | 3,328 | 29,098 |
| AVERAGE PERCENT | 55 | 9 | 13 | 14 | 9 | 100 |

SOURCE: *Manitoba Dept. of Mines, Resources and Environmental Management fur dealer returns, The Pas.*

EFFECT ON WILDLIFE USE - Shoreline hunting opportunity by natives will decrease and trapping will be affected through flooding of furbearer habitat.

Effect on Hunting - The native moose harvest will be directly affected as shoreline moose production potential will be lost through flooding. Assuming that 75 percent of moose harvested are currently shot along shorelines, 75 percent of the value of the moose harvest could be lost after flooding unless an adjustment is made in hunting patterns.

Increased access into the area will increase recreation hunting. While limited accessibility will prohibit most hunters from going into the northern sections, the South Bay area is accessible by road from Leaf Rapids and Thompson. This could lead to an increase in moose hunting around Opachuanau Lake and South Bay. Increased recreation hunting may result in a conflict with subsistence hunting by natives. As the area has a low production potential, management regulations may be necessary to allow natives to harvest sufficient moose for food and hides. Some harassment of ungulates will occur with increased access to the area, but should not be of major concern.

The economic aspects of hunting are discussed in detail in the community section.

Effect on Trapping - Trapping blocks along the lake will be affected to varying degrees by flooding, area lost ranging from 1 to 5 percent. The actual effect may be greater than the percent of land area lost. Shorelines and marsh areas, particularly in the southern sections where most of the trapping is done, probably contribute more to furbearer production and are trapped more intensively than inland areas. It is expected that beaver, mink and muskrat will be reduced in numbers.

Trapping blocks affected and the economic implications of fur production loss are discussed in detail in the community section.

## FOREST RESOURCES AND FORESTRY

With the increase in the water level of Southern Indian Lake, a loss of forest resources due to flooding will occur. The Forest Inventory Section, Manitoba Department of Mines, Resources and Environmental Management, determined the forestry volume losses, and assessed the implication of these losses in terms of the forestry potential of this area.

FOREST RESOURCES - The forest resources study included the area bounded by Granville Lake, Opachuanau Lake and Southern Indian Lake up to Missi Falls. To facilitate a more accurate assessment of the impact of flooding on the forest resources the area is discussed on the basis of; forest region, status of land (productivity and ownership) and forest Management Units.

There are two forest regions: the northern coniferous forest zone in the south and the north-western transition zone in the north. The boundary line between the two regions runs approximately where the 57° north parallel of latitude crosses the lake. Distinguishing features between the zones depend mainly on macro-features of vegetation. The northern coniferous forest (Fig. 8-13) is characterized by a continuous forest of conifers with black spruce (*Picea mariana*) the dominant species. Jack pine (*Pinus banksiana*), white spruce (*Picea glauca*), white birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*) form a minor component. The forest vegetation of the northwestern transition zone (Fig. 8-14) is described as open subarctic woodlands.[8-1] In the southern zone, tree growth is quite good, while further north, in the transition zone, rate of growth decreases due to climate. Most of the denser stands of spruce and mixed-wood occur in a very narrow

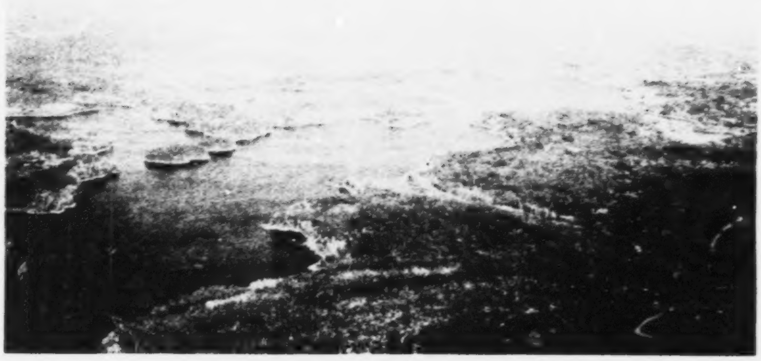


Fig. 8-13. Photograph of Northern Coniferous Zone Between Leaf Rapids and Opachuanau Lake.

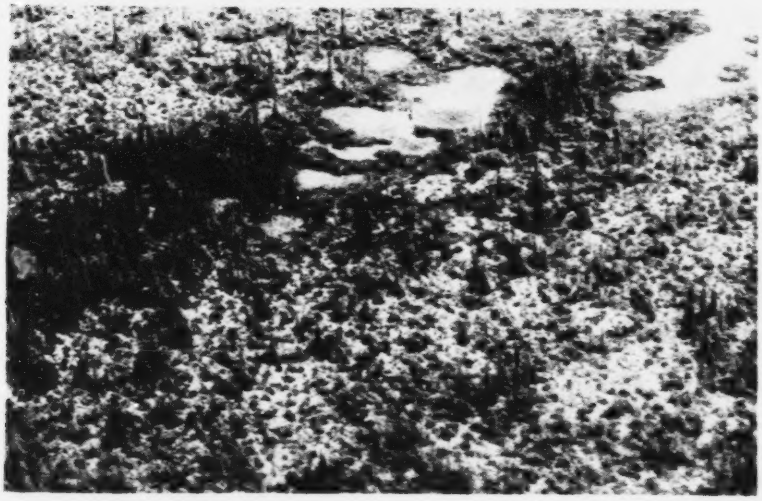


Fig. 8-14. Photograph of North-western Transition Zone Forest.

band along the lake where a moderating influence affords better growth.

These forest regions are further classified by status of land; the proposed permanent forest zone and the Manitoba Forestry Resources Ltd specified area. The proposed permanent forest zone consists of forest Management Units 71, 72, 73, and 75 while the specified area comprises forest Management Units 64 and 66.

EFFECT ON FOREST RESOURCES - The study area has been contour mapped and the 850-ft elevation contour has been designated as the boundary of inundation after diversion. Based on the boundary, 135,534 acres or 211.8 square miles of land will be flooded. Productivity of the land to be flooded is subdivided on the basis of status and ownership of the land. Productivity includes, basically, two divisions; productive forest land and non-productive land.

Two types of productive land are recognized: potentially productive forest land and productive forest land. Potentially productive land includes areas on which there is a potential to produce a merchantable stand of trees, such as areas where the vegetation has been removed either by forest fires or by man. Productive land includes all forest land capable of producing merchantable wood.

Non-productive types include forested non-productive land and non-forested land. Non-productive land includes all forest land not capable of producing merchantable timber due to very low productivity. Non-forested land includes areas that are withdrawn from timber production, and areas not capable of producing merchantable timber, such as barren rock, muskeg, and marsh.

A summary of the flooding by productivity and zone is given in Table 8-17. Of the total area to be flooded almost 60 percent is classed as productive land and is now producing merchantable trees, or has the potential for so doing. Therefore, productive area lost will be high, but because of poor growth, timber volume lost will be relatively low.

Effect on Manitoba Forestry Resources Specified Area - The land area to be flooded in this zone is 6945 acres. Typical treed-muskeg vegetation covers 914 acres, 3055 acres are timber covered (productive land) and 2976 acres have little or no forest cover. Softwoods such as jack pine, black spruce and white spruce cover 2371 acres and hardwoods cover 562 acres.

It is estimated that 23,370 cunits (a cunit is equivalent to 100 cubic feet) of gross merchantable softwood and 6530 cunits of gross merchantable hardwood will be lost. Gross merchantable is a volume measure of all tree species with diameters

TABLE 8-17
SOUTHERN INDIAN LAKE
SUMMARY OF LAND TO BE FLOODED BY PRODUCTIVITY AND ZONE (IN ACRES)

| | Northern Coniferous Forest Zone | | Northwestern Transition Zone | Total | Percent |
|---|---|---|---|---|---|
| | Manitoba Forestry Resources Limited (Specified Area) Management Units 64 & 66 | Proposed Permanent Forest Management Units 71,72 & 73 | Proposed Permanent Forest Management Unit 75 | | |
| Productive Forest | 3,055 | 52,655 | 24,091 | 79,801 | 58.9 |
| Forested Non-Productive | 914 | 13,160 | 28,008 | 42,082 | 31.0 |
| Non-Forested | 2,976 | 1,864 | 8,811 | 12,651 | 10.1 |
| Total Land Flooded | 6,945 | 67,679 | 60,910 | 135,534 | 100.0 |
| Percent by Zone | 5.1 | 49.9 | 45.0 | 100.0 | -- |

of 3.6 inches and larger, measured 4.5 ft above ground level.

Net merchantable volume estimates of wood to be lost in the Southern Indian Lake area are given in Table 8-18. The net merchantable volume is determined by applying cull factors to cover decay, breakage and harvesting loss to be expected in the area. Total loss of net merchantable volume will be 270,260 cunits, of which 26,650 cunits are in the specified area.

TABLE 8-18
SOUTHERN INDIAN LAKE LOSS OF NET MERCHANTABLE VOLUME THROUGH FLOODING BY ZONE AND DIAMETER CLASS (IN CUNITS)[1]

| Species | Specified Area Management Units 64 & 66 | | | Proposed Permanent Forest Zone Management Units 71,72 &73 | | | Proposed Permanent Forest Zone Management Unit 75 | | | Total Loss of Net Merchantable Volume | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4"-9" | 10"+ | Total | 4"-9" | 10"+ | Total | 4"-9" | 10"+ | Total | 4"-9" | 10"+ | Total |
| Jack Pine | 1,610 | 380 | 1,990 | 5,790 | 400 | 6,190 | 140 | -- | 140 | 7,540 | 780 | 8,320 |
| Black Spruce | 16,970 | 910 | 17,880 | 184,270 | 8,140 | 192,410 | 31,000 | 290 | 31,290 | 232,240 | 9,340 | 241,580 |
| White Spruce | 1,040 | 730 | 1,770 | 1,920 | 1,040 | 2,960 | -- | -- | -- | 2,960 | 1,770 | 4,730 |
| Balsam Fir | 80 | -- | 80 | 20 | 10 | 30 | -- | -- | -- | 100 | 10 | 110 |
| Tamarack Larch | 10 | -- | 10 | 80 | 10 | 90 | 30 | -- | 30 | 120 | 10 | 130 |
| Total Softwood | 19,710 | 2,020 | 21,730 | 192,080 | 9,600 | 201,680 | 31,170 | 290 | 31,460 | 242,960 | 11,910 | 254,870 |
| Trembling Aspen | 3,480 | 600 | 4,080 | 3,900 | 400 | 4,300 | 20 | -- | 20 | 7,400 | 1,000 | 8,400 |
| Balsam Poplar | 300 | 60 | 360 | 410 | 80 | 490 | -- | -- | -- | 710 | 140 | 850 |
| White Birch | 460 | 20 | 480 | 5,310 | 20 | 5,330 | 330 | -- | 330 | 6,100 | 40 | 6,140 |
| Total Hardwood | 4,240 | 680 | 4,920 | 9,620 | 500 | 10,120 | 350 | -- | 350 | 14,210 | 1,180 | 15,390 |
| Total Loss | 23,950 | 2,700 | 26,650 | 201,700 | 10,100 | 211,800 | 31,520 | 290 | 31,810 | 257,170 | 13,090 | 270,260 |
| Percent by Zone | -- | -- | 9.9 | -- | -- | 78.4 | -- | -- | 11.7 | -- | -- | 100.0 |

[1] *One cunit equals 100 cubic feet.*

The total net operable volume which will be lost by the flooding is 4420 cunits, of which 3430 are black spruce. Net operable volume is the volume of all operable stands. An operable stand is one which contains a minimum of 800 cubic feet per acre, in cutting classes 4 and 5 only, of the four major softwood species (jack pine, black spruce, white spruce and balsam fir) excluding trees less than 4 inches in diameter.

## Effect on the Proposed Permanent Forest Zone

Forest Management Units 71, 72 and 73 - The land area to be flooded in this region is 67,679 acres. Typical treed-muskeg vegetation covers 13,160 acres; 52,655 are timber covered (productive land) and 1864 acres have no forest cover. Softwoods cover 43,737 acres; the majority being black spruce, 40,435 acres; and hardwoods cover 5628 acres.

It is estimated that 216,860 cunits of gross merchantable softwood and 12,980 cunits of hardwood will be lost. Approximately 78 percent of the total loss of net merchantable volume will occur in this area. Loss of net operable volume will be 34,510 cunits (88.6 percent) of the total volume in the Southern Indian Lake area.

Forest Management Unit 75 - This is the only forest Management Unit in the northwestern transition zone of the area and hence tree characteristics affecting volume are different from those in the other areas. The land area to be flooded in this region is 60,910 acres. Typical treed-muskeg vegetation covers 28,008 acres, 22,888 are timber covered, 1203 acres are potentially productive, and 8811 acres have no forest cover. Softwoods (mainly black spruce) cover 21,912 acres and hardwoods 976 acres.

It is estimated that 33,230 cunits of gross merchantable softwood and 430 cunits of hardwood will be lost. Of the net merchantable volume (31,810 cunits) lost, 31,460 cunits are softwood. No operable volume is found in Management Unit 75 due to poor tree growth and hence operating in this region is not justifiable from the standpoint of forest economics.

FORESTRY - Timber around Southern Indian Lake is mostly spruce. Some pine is found in the vicinity of Leaf Rapids and there is a small amount of aspen and birch near the shoreline, but none of this is of commercial value. Present forestry operations are limited to the local need for building materials and fuel. Although

Manitoba Forestry Resources Ltd holds permits to cut, they have not set up any operations within the area. The land not held by Manitoba Forestry Resources Ltd as yet, has not been committed to any wood-utilizing organization. Based on net operable volume throughout the study area, any forestry operation would be marginal at best.

Annual allowable cut calculations have been made for all forest Management Units in order to provide guidelines for harvest on an annual basis. Both theoretical and practical annual allowable cut have been determined. In determining the practical annual allowable cut, a margin is allowed for losses in area and volume due to fire, new construction and withdrawals from commercial harvesting operations. In all forest Managment Units, a 12 percent reduction factor was used to calculate this margin. The theoretical annual allowable cut is the total amount of volume available annually using all species, and taking into account no restraints on economic feasibility of harvesting the wood.

EFFECT ON FORESTRY - Although there will be a loss of productive forest land in the area, improved accessibility may make future forestry operations more economical. Developments, such as the new South Bay road, will make transport easier and less costly. New docking sites and improved water transport to Leaf Rapids will also aid in reducing shipping costs.

The major portion of the land to be flooded occurs in areas which are not presently being utilized by the forestry industry. Only 5 percent of the loss will occur on land which is already allocated to Manitoba Forestry Resources Ltd.

Approximately 100 sites are to be cleared on Southern Indian Lake to allow for landing areas for fishermen and hunters. Clearing operations will provide employment and training for local people in forest harvesting operations.

The effect of flooding on total potential annual allowable cut is insignificant (Table 8-19). Throughout the entire area the total loss of theoretical annual cut is 3280 cunits over an area of 428 acres. The total loss of practical annual allowable cut for the area is 1680 cunits over an area of 185 acres (Table 8-20). Black spruce will be the only working group affected.

TABLE 8-19
SOUTHERN INDIAN LAKE LOSS OF THEORETICAL ANNUAL ALLOWABLE CUT THROUGH FLOODING BY ZONE, DIAMETER CLASS AND SPECIES (IN CUNITS)

| Species | Specified Area Management Units 64 & 66 | | | Proposed Permanent Forest Zone Management Units 71,72 & 73 | | | Proposed Permanent Forest Zone Management Unit 75 | | | Total Loss of Theoretical Annual Cut | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4"-9" | 10"+ | Total | 4"-9" | 10"+ | Total | 4"-9" | 10"+ | Total | 4"-9" | 10"+ | Total |
| Jack Pine | 30 | 10 | 40 | 10 | -- | 10 | -- | -- | -- | 40 | 10 | 50 |
| Black Spruce | 190 | 10 | 200 | 2,290 | 100 | 2,390 | 550 | -- | 550 | 3,030 | 110 | 3,140 |
| White Spruce | 10 | -- | 10 | 20 | 20 | 40 | -- | -- | -- | 30 | 20 | 50 |
| Total Softwood | 230 | 20 | 250 | 2,320 | 120 | 2,440 | 550 | -- | 550 | 3,100 | 140 | 3,240 |
| Trembling Aspen | 10 | -- | 10 | -- | -- | -- | -- | -- | -- | 10 | -- | 10 |
| White Birch | -- | -- | -- | 30 | -- | 30 | -- | -- | -- | 30 | -- | 30 |
| Total Hardwood | 10 | -- | 10 | 30 | -- | 30 | -- | -- | -- | 40 | -- | 40 |
| Total Loss | 240 | 20 | 260 | 2,350 | 120 | 2,470 | 550 | -- | 550 | 3,140 | 140 | 3,280 |
| Percent by Zone | -- | -- | 7.9 | -- | -- | 75.3 | -- | -- | 16.8 | -- | -- | 100.0 |

TABLE 8-20
SOUTHERN INDIAN LAKE LOSS OF PRACTICAL ANNUAL ALLOWABLE CUT THROUGH FLOODING BY ZONE, SPECIES AND DIAMETER GROUP (IN CUNITS)

| Species | Specified Area Management Units 64 & 66 | | | | Proposed Permanent Forest Zone Management Units 71,72,73. | | | | Proposed Permanent Forest Zone Management Unit 75 | | | | Total Loss of Practical Annual Cut | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5" | 6"-9" | 10"+ | Total | 5" | 6"-9" | 10"+ | Total | 5" | 6"-9" | 10"+ | Total | 5" | 6"-9" | 10"+ | Total |
| Jack Pine | -- | 20 | -- | 20 | -- | 10 | -- | 10 | -- | -- | -- | -- | -- | 30 | -- | 30 |
| Black Spruce | 40 | 100 | 10 | 150 | 480 | 900 | 80 | 1,460 | -- | -- | -- | -- | 520 | 1,000 | 90 | 1,610 |
| White Spruce | -- | -- | 10 | 10 | -- | 20 | 10 | 30 | -- | -- | -- | -- | -- | 20 | 20 | 40 |
| Balsam Fir | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total Softwood Loss | 40 | 120 | 20 | 180 | 480 | 930 | 90 | 1,500 | -- | -- | -- | -- | 520 | 1,050 | 110 | 1,680 |
| Percent by Zone | -- | -- | -- | 10.7 | -- | -- | -- | 89.3 | -- | -- | -- | Nil | -- | -- | -- | 100.0 |

Effect on the Specified Area - Annual allowable cut loss through flooding in the specified area is compared with total volume available only in Management Unit 64. The loss in area and volume of black spruce is 0.33 percent of the total potential allowable cut through flooding. This figure is well within the 12 percent reduction factor, and thus the practical annual allowable cut will not have to be reduced.

Effect on Forest Management Units 71, 72 and 73 - The greatest loss of theoretical cut occurs in this zone (2470 cunits per annum). The major portion of loss in practical cut will also occur in this area (about 90 percent of the total loss). No relative comparison of loss is available as estimates of allowable cut for entire

Management Units are not available.

Effect on Forest Management Unit 75 - No practical annual cut will be lost in this zone, since no stands qualify as being operable.

## OUTDOOR RECREATION RESOURCES AND THEIR UTILIZATION

On the basis of identified potential outdoor recreation sites, the recreation resources of the Southern Indian Lake area from Leaf Rapids to Moss Lake were assessed and the recreation potential defined. Based on this assessment, an outdoor recreation listing was developed within the policy constraints of the Parks Branch, Manitoba Department of Tourism, Recreation and Cultural Affairs, on the assumption of no diversion project. An assessment of the project was related to a loss of resources and a change in the resource base due to the project. The impact of water regime changes on identified potential recreation sites was evaluated. A second recreation inventory was developed taking into account these changes, and the variation between pre- and post-flooding conditions was taken as the benefits or losses to recreation from the diversion project.

The Southern Indian Lake area is too large and inaccessible to be used for intensive recreation use. Much of the lake shoreline is unsuited to cottage development and any development would require construction of many miles of access roads through difficult terrain. Because of these problems, compounded by the treacherous nature of the lake, the area will remain an extensive recreation area oriented to the natural resources. The area is not lacking in recreation capability. The long narrow bays area (56°50'N to 57°15'N and 99°0'W to 99°30'W) on the west side of the lake is ideal for wilderness boating and camping, fishing, hunting and possible resort operations. Many of the bays have small streams or rivers with exceptional sport fishing for northern pike and walleye. The only drawback is accessibility. The prime recreation orientation will be directed to water use for power boating and sport fishing.

### OUTDOOR RECREATION RESOURCES

Recreation Potential Without Diversion - The recreation possibilities for the Southern Indian Lake area without the diversion project envisage the activities and facilities listed below:

- A wilderness area designated in the narrow bays area on the west side offers sheltered boating, good fishing and some lovely scenery.

- Construction of five outdoor recreation facilities along the extension of Provincial Road 391 between Thompson and Lynn Lake. The projects include: a major campground and recreation area on the Churchill River at its junction with Granville Lake near Leaf Rapids; a mini-park at Suwannee River, 25 miles south of Leaf Rapids; waysides and access sites at Hughes River, Eden Lake and Hughes Lake between Leaf Rapids and Lynn Lake.
- Sport fishing on both Opachuanau and Southern Indian lake, Barrington and McBride rivers.
- A tourist excursion business operated by the South Indian Lake Fisheries Co-op Ltd. Small cabins would be built at the mouths of rivers or bays to be used for fishing and hunting.
- Interpretive areas could be developed at the archaeological sites (Kame Hills and Sandhill Bay) on Southern Indian Lake.
- Canoeing on the route downstream on the Churchill River between Leaf Rapids and Opachuanau Lake and in the McBride and Barrington lakes area.
- A narrow bays area on the west shore of Southern Indian Lake is suitable for a commercial lodge operation.
- Possibilities for development of a potential historic site complex at the Leaf Rapids portage site.

Recreation Potential With Diversion - The conceptual recreation listing with the diversion project envisages the following:

- The narrow bays area is an excellent location for a commercial fly-in lodge if the sport fishing capability is increased. This area due to its sheltered nature could also be used for wilderness canoeing and camping.
- Improved navigation on the Churchill River will result in more people from Leaf Rapids using the area. Boat landing areas will have to be cleared along the shoreline.
- The McBride and Barrington rivers area will still provide opportunities for boating, fishing, swimming and camping and access may be improved. The construction of a barge landing on the Barrington River will make road access possible and a wayside picnic area may be necessary.
- The road into South Bay, the barge landing and the eventual extension of the road to South Indian Lake will necessitate the provision of facilities such as wayside and campground areas. South Indian Lake community would

supply guides and outfitting services for wilderness canoe trips, fishing and hunting trips.

EFFECT ON OUTDOOR RECREATION RESOURCES - The rise in levels of Southern Indian Lake Opachuanau Lake and the Churchill River will cause changes in the resource base which will have implications for recreation. By comparing the conditions with and without the diversion project, the following conclusions were drawn regarding the effects on the recreation potential of the Southern Indian Lake area.

The diversion project will result in the following potential gains to outdoor recreation:

- Regulation will result in increased water depth and increased recreation capability for swimming and beach activities in the inlet of the Churchill River downstream from the rapids and adjacent to the east side of the industrial area of Leaf Rapids.
- An opportunity exists to enhance the increased recreation capability of this inlet by clearing, grubbing and burning vegetation.
- Sport fishing is expected to continue or to improve following regulation. Increased accessibility created by the diversion project road to South Bay and extension of Provincial Road 391 to Lynn Lake will enable the sport fishing potential to be more fully realized.
- A substantial boost to the local economy and a favourable climate for investment in accommodation and service centre facilities will be created as a result of the sport fishing potential being more fully realized.
- Higher water levels on the Churchill River will eliminate stretches of fast water and increase depth in shallow areas, making navigation easier. Improved navigation will result in more people from Leaf Rapids using the area.

The diversion project will result in the following potential losses to outdoor recreation:

- The recorded archaeological sites in the area which could attract visitors will be largely inundated (92 percent) by flood waters.
- Flooding as a result of the diversion will result in general degradation of scenic quality due to flooded shoreline vegetation and clay bank slumpage and reduced recreation potential.
- Shoreline accessibility will be impaired by standing flooded timber resulting in a decrease of recreation potential.
- Construction of control structures over the north and south channels of

Missi Falls and increasing the water level to cover rapids at the mouths of rivers flowing into Southern Indian Lake will result in permanent loss of these scenic areas. The 6 ft drop at Leaf Rapids on the Churchill River will be reduced by as much as 4 ft, thus decreasing the scenic value of this accessible area.

- Exposed reefs and rock islands will become submerged, creating potential new hazards for boaters. Greatly increased numbers of floating and submerged logs will also increase hazards to boaters.
- Quality of the canoeing experience will be reduced considerably if the timber to be flooded along shorelines is not cleared.
- Due to the flooding, the unrealized hunting potential, even though new roads have been built, will continue since habitat shoreline will be inaccessible to hunters.
- An opportunity to provide fishing excursions could be threatened if adequate boat landing areas are not cleared and some restoration of aesthetic quality by pre-clearing is not done at the mouths and to the limit of flooding of tributaries flowing into the Churchill River to Opachuanau Lake and Southern Indian Lake.

USE OF OUTDOOR RECREATION RESOURCES - Use of the area for recreation is limited as a result of the inaccessibility of the area. Present recreation facilities in the Southern Indian Lake area are: a cabin at the confluence of the McBride and Barrington rivers; a ski hill under construction at Leaf Rapids; a small beach-picnic area developed near South Indian Lake; a baseball diamond and swimming area on Turnbull Lake; and a forty unit campground to be built on Granville Lake just off Provincial Road 391 by the Parks Branch, Manitoba Department of Tourism, Recreation and Cultural Affairs.

Occasionally, canoeists travel the traditional canoe route from Southern Indian Lake to Moss Lake and across the watershed division into the Seal River system to the coast of Hudson Bay and Churchill as well as the more sheltered route through the narrow bays to Big Sand Lake.

EFFECT ON THE USE OF OUTDOOR RECREATION RESOURCES - With the additional transportation services and facilities as a result of the diversion project, Southern Indian Lake will be more accessible and future travel to this area for outdoor recreation is expected to increase. Greatest recreation use will occur in the following areas:

Churchill River to Opachuanau Lake; Barrington River to Opachuanau Lake; the tributary river flowing from 8 miles north of Leaf Rapids into the Churchill River; Opachuanau Lake; South Indian Lake community and environs; mouths of tributary rivers; and if it becomes accessible, the narrow bays area.

## TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES

The implications of the diversion project to transportation and navigation in the Southern Indian Lake area are discussed in this section. The existing transportation and navigation facilities and services, the physical effects of the diversion project on the present and proposed facilities and services, implications of the project on existing methods of removing resource products, and possible modifications to existing transportation services to the communities in the area are examined.

TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES - Existing transportation services and facilities in the Southern Indian Lake area are shown in Fig. 8-15. The only land link with the southern region of the province is provided by Provincial Road 391. South Indian Lake has a freight service by barge to Leaf Rapids, South Bay and Missi Falls. Commercial air routes serve the area and charter service is available.

Provincial Road 391, an all-weather gravel road from Thompson to Lynn Lake, serves Leaf Rapids. Other all-weather gravel roads have been built by the Manitoba Department of Highways from Leaf Rapids to Ruttan Lake to service the Sherritt Gordon mine site north of the lake, and from Ruttan Lake to the southern end of South Bay on Southern Indian Lake to provide access to the diversion channel construction site and to provide the initial link in a barge operation to the Missi Falls control structure site.

Two winter roads serve the Southern Indian Lake area. The Manitoba Department of Northern Affairs constructs and operates a winter road from the South Bay terminus of the Leaf Rapids-Ruttan Lake-South Bay all-weather road to South Indian Lake community. Manitoba Hydro constructs and operates a winter road from South Bay to Missi Falls control structure construction site. Until the Missi Falls control structure is completed, overland access will be provided to Missi Falls via this South Bay-Missi Falls winter road.

Navigation is possible on Southern Indian Lake from Leaf Rapids to Missi Falls. Docks exist at Leaf Rapids, South Indian Lake community, and Missi Falls. To

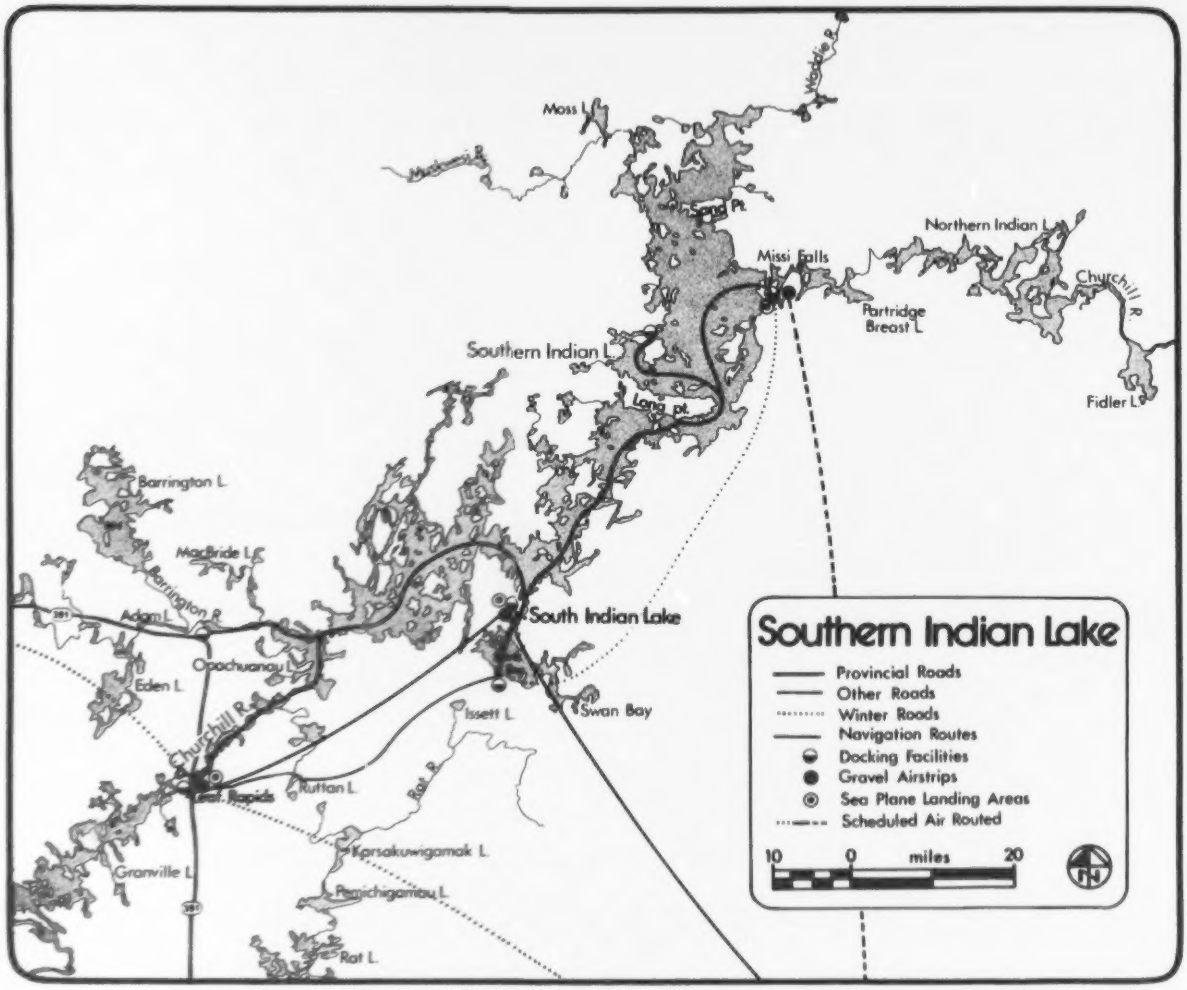

Moss L.
Waddie R.
Muskwesi R.
Sand Pt.
Northern Indian L.
Missi Falls
Churchill R.
Partridge Breast L.
Southern Indian L.
Fidler L.
Long pt.
Barrington L.
MacBride L.
Barrington R.
Adam L.
391
South Indian Lake
Opachuanau L.
Eden L.
Churchill R.
Issett L.
Swan Bay
Leaf Rapids
Ruttan L.
Rat R.
Karsakuwigamak L.
Granville L.
Pemichigamau L.
Rat L.
Southern Indian Lake
Provincial Roads
Other Roads
Winter Roads
Navigation Routes
Docking Facilities
Gravel Airstrips
Sea Plane Landing Areas
Scheduled Air Routed
10
0
miles
20

Fig. 8-15. Map of Southern Indian Lake Region Transportation System.

provide access to construction sites, Manitoba Hydro has provided docking facilities at South Bay at the terminus of the Ruttan Lake-South Bay road. Construction materials and supplies are transported by barge in summer to Missi Falls where Manitoba Hydro has constructed a major wharf facility. There are also a number of smaller docks at the fish camps on the lake.

Apart from use of small motor boats and canoes on other waterways, navigation is confined to the lake which is navigable throughout most of its area. The most frequently travelled routes are from Leaf Rapids to South Indian Lake (used primarily by commercial fishermen) and South Bay to Missi Falls (used to supply the construction site). The most hazardous reach of water on the navigation route is from Leaf Rapids to Opachuanau Lake due to stretches of rapids and shallow depth.

Other than this area, the navigation routes are basically hazard free. Extent of the navigation season on Southern Indian Lake is from the first week of June to the last week of October.

South Indian Lake and Leaf Rapids communities and the construction sites at South Bay and Missi Falls have floatplane bases and landing areas. A floatplane base serving Leaf Rapids has two landing approaches. The landing site is an area between the Churchill River bridge crossing and a stretch of rapids at an approximate elevation of 850 to 855 ft. The floatplane base serving South Indian Lake is located on the lake. The length of the landing site is approximately 2 miles and it is situated directly south of the community. The base, operated jointly by Midwest Airlines Ltd., Lambair Limited and Manitoba Government Air Division, has docking facilities. Air service to the South Bay construction site is provided by float equipped aircraft. Until a major airstrip was completed by Manitoba Hydro at Missi Falls in the fall of 1973, air transport needs were met by float equipped aircraft.

Airstrips are located at Leaf Rapids, South Indian Lake and at Missi Falls community. The Leaf Rapids airstrip, a 4000-ft runway with gravel surface, is owned by the Province of Manitoba. The airstrip at South Indian Lake is also provincially owned. The runway is gravel over clay surface, 2000 ft in length. It is located 200 yards inland on the east side of the narrows.

EFFECT ON TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES - The portion of road from Leaf Rapids to Ruttan Lake mine site is of sufficient elevation and far enough distant from the reservoir which will be created upstream of the Notigi control structure so as to be unaffected by the higher water levels. The remaining portion of the access road from Ruttan Lake to South Bay has a generally good alignment and has been constructed so that it will not be flooded when the Churchill River diversion project is completed. Thus road access to South Bay from Leaf Rapids and Provincial Road 391 will remain unimpaired. This road to South Bay could become the initial link in any future all-weather road extension to South Indian Lake community, approximately 10 miles distant. In the meantime the road has brought surface transportation of people and goods much closer to the community.

The winter road may be affected by changes in the ice regime in the vicinity of the South Indian Lake community. Small patches of open water are likely to remain year-round in the narrows opposite the site of the new town centre. The ice in the immediate vicinity of this open water may not be thick enough to withstand the heavy trucks which travel on the winter road. The South Bay-Missi Falls winter road route initially crosses portions of South Bay and this section also may be affected by changes in the ice regime as a result of diversion. However, the largest portion of the South Bay-Missi Falls winter road follows an overland route, and should not be affected by ice conditions on Southern Indian Lake.

The level of Southern Indian Lake will be raised to a maximum elevation of 847 ft. Depending on the type of vessel which will be used and present depth of the navigable channels, the rise in lake level could improve the navigability of the shallow stretch of water from Opachuanau Lake to Leaf Rapids. It is also possible that navigation upstream of Leaf Rapids in the Granville Lake area may be improved by the higher water levels.

The higher levels on Southern Indian Lake will result in total or partial inundation of many small islands, creating reefs and shallows along both major navigation routes. This would be of particular significance in the southern portion of the lake which has an abundance of small islands. These submerged and/or partially submerged islands could be hazardous to navigation. Provision for marking these islands as aids to navigation would require their identification and information on the extent to which they may be flooded. Of direct concern to navigation is shoreline accessibility after diversion. Flooding of tree stands along the lakeshore will impair the ability of vessels to approach the shore. The timber clearing operations on Southern Indian Lake will provide access to the shoreline at selected points.

As part of the South Indian Lake community development program, a main dock with several secondary docks are to be built. The main dock will also serve as a berthing area for floatplanes. These new facilities will be constructed at an elevation well above 850 ft and should not be affected by the Churchill River diversion project.

The docks at the fish camps on Southern Indian Lake were built at elevations varying from 839 to 847 ft, with the majority between 839 to 842 ft. Since the elevation of the lake could rise even higher during flood periods to a maximum of 850 ft, all of these docks would be flooded.

The floatplane base at Leaf Rapids, as a result of its location and elevation, should encounter no adverse effects either from fluctuations in water level or alterations in current flow. Alterations to the existing current flow at the floatplane base at South Indian Lake community may occur, with a maximum increase to 30,000 cfs after diversion. As part of the development program for the community, the base will be moved from its present location on the west side of the narrows to the site of the new main dock on the east shore. Since the level of the Churchill River at Leaf Rapids is not expected to rise above its present stage (850 ft), it may be assumed that the airstrip at Leaf Rapids will not be affected by the diversion project. The airstrip at South Indian Lake community, which is at an elevation of 900 ft, will not be affected by the raising of Southern Indian Lake to elevation 847 ft.

EFFECT ON EXISTING AND POTENTIAL RESOURCE PRODUCTS TRAFFIC - Southern Indian Lake has sustained one of the more important commercial fisheries in Manitoba (about 5 percent of the total provincial fish catch) with an average annual catch of approximately 1,000,000 lb (combined summer and winter seasons). Fish caught on Southern Indian Lake and surrounding lakes in summer are brought to one of four collecting stations on Southern Indian Lake or directly to Leaf Rapids from certain lakes. The winter fishery is operated exclusively on Southern Indian Lake with Loon Narrows as the collection point. Fish caught in summer in outlying lakes are iced at the lake and transported to the collection stations on Southern Indian Lake or Leaf Rapids by air. The South Indian Lake Co-op Fisheries Ltd. fish processing plant is located at Leaf Rapids. From the collection stations fish are transported by refrigerated boat to the processing plant at Leaf Rapids. Fish caught in winter are transported from the collecting point at Loon Narrows by air to Leaf Rapids for processing. In the past, processed fish have been transported by truck from Leaf Rapids to Lynn Lake and then by rail to Winnipeg. With completion of Provincial Road 391 to Leaf Rapids, fish can be trucked directly to Winnipeg via Provincial Road 391 and Provincial Trunk Highway 6. Transportation of fish via this route should encounter little difficulty as a result of the diversion project.

The rise in the level of Southern Indian Lake will alter the location of existing fishing areas and could result in changes in the internal navigation patterns of fishermen. Partial inundation of islands in the lake may cause navigational difficulties for both fishermen and the fish collecting boats. Flooding of shoreline tree stands may impair accessibility to fishing areas close to shore.

The Churchill River diversion project should have little effect, however, on the methods of removing fish from lake to plant provided navigational hazards are marked and the Leaf Rapids-South Indian Lake water route is charted.

The discovery of nickel at Ruttan Lake, 15 miles east of Leaf Rapids, by Sherritt Gordon Mines Limited in the late 1960's resulted in establishment of the new community of Leaf Rapids. The mining operations at Ruttan Lake will not be adversely affected by the diversion project since the mine is situated several miles to the west of the forebay which will be created by the diversion from the Churchill River via South Bay. Mineral output from the Ruttan mine is shipped by truck from the mine site via the Ruttan Lake road and Provincial Road 391 to Lynn Lake. The Ruttan Lake-Leaf Rapids road will not be affected by the Churchill River diversion project and the method of transporting ore concentrates will be unaltered.

EFFECT ON TRANSPORTATION SERVICES TO SOUTH INDIAN LAKE AND LEAF RAPIDS COMMUNITIES - Leaf Rapids and South Indian Lake are served by air on a scheduled and/or charter basis. The services involve both passenger and freight movements. Improvements to existing airstrips and construction of new facilities resulting from the increased activity caused by hydro construction could provide an initial stage in overall improvement of air services in the area.

With completion of the Thompson-Lynn Lake road (Provincial Road 391), Leaf Rapids is now connected to the provincial highway network. This all-weather road has facilitated the movement of both people and freight in the area.

The community of South Indian Lake is not accessible by all-weather road to the provincial highway network and depends on a winter road to provide surface accessibility. However, as noted previously, completion of the Ruttan Lake-South Bay access road to within 10 miles of the South Indian Lake community provides the initial link of an eventual all-weather road access to South Indian Lake. Access to the communities in the Southern Indian Lake area is provided in part by the Lynn Lake branch line of the Canadian National Railways. Passengers and freight which reach Lynn Lake can then proceed by all-weather road to Leaf Rapids. Completion of the Thompson-Lynn Lake road has made it possible for the communities to be served entirely by all-weather or winter road.

The Churchill River diversion project is expected to affect existing internal transportation facilities in the South Indian Lake community. The community is undergoing extensive redevelopment which, when completed, will see relocation of the present shopping and nursing facilities from their locations on the west shore of the narrows of Southern Indian Lake to the east shore. Relocation and development of the town centre on the east side of the community includes new housing sites for residents and pedestrian-oriented road access to the town centre and the airstrip. Some residents will remain on the west side of the narrows; these residents will cross the narrows by boat in summer and would normally cross on the ice in winter either on foot or by snowmobile. With diversion, sections of the narrows are expected to remain open and the remaining sections will have unsound ice cover. Residents therefore will not be able to cross from one side of the community to the other. An intercommunity winter transport link will have to be provided by some means such as developing a winter crossing in the narrows area linked by overland winter roads parallel to the shoreline.

Development of the east shore of the community will involve construction of roads which are more for pedestrians than vehicles due to lack of vehicles in the community and lack of road access to the rest of the province. These roads will be constructed for the most part at an elevation above 860 ft and will not be adversely affected by the diversion project.

An analysis was made of the transportation cost implications of hydro-initiated transportation infrastructure extensions on commodities brought into the South Indian Lake community. Without the hydro-initiated road from Ruttan Lake to South Bay, an all-weather road connection from Ruttan Lake to South Indian Lake would have involved a capital outlay of $3,750,000 plus annual maintenance of $65,000. Since the Ruttan Lake-South Bay all-weather road extension was built at a cost to Manitoba Hydro of $2,250,000 with annual maintenance cost at $40,000, the financial contribution has reduced the cost of the road (South Bay-South Indian Lake extension) to $1,500,000 plus annual maintenance cost of $25,000. On an annual basis, the cost reduction could amount to $152,500 per year over a 20 year period.

Completion of an all-weather road to South Indian Lake is expected to reduce total annual transport costs for importation of commodities (perishables, dry groceries, dry goods and petroleum products) to the community. It has been estimated that total annual transport costs could be reduced by 50 percent, from $23,525 in 1973 to $10,572 if an all-weather road access to South Indian Lake were completed.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON COMMUNITIES

There are two permanent communities situated in the study area; South Indian Lake and Leaf Rapids. The effect of the Churchill River diversion project on the community of South Indian Lake was evaluated by the Planning Branch, Manitoba Department of Mines, Resources and Environmental Management. Leaf Rapids was not examined as the impact of the project on it is expected to be negligible. The effect of the diversion project on the economy, the labour force, community infrastructure, and the social system of South Indian Lake are discussed in this section.

## SOUTH INDIAN LAKE

The community of South Indian Lake is located on the narrows between the main body of Southern Indian Lake and South Bay. It is approximately 85 miles northwest of Thompson, 80 miles southeast of Lynn Lake and 40 miles northeast of Leaf Rapids. South Indian Lake is relatively isolated, having no all-weather road or rail access. Its population is approximately 590 of which about 400 are Registered Indians. The populated areas are scattered along both sides of the narrows for a distance of about 3 miles. (Fig. 8-16). Because the community is located entirely on Crown Land, its government (mayor and council) relate to the Manitoba Department of Northern Affairs.

THE ECONOMY - For purposes of analysis the economy of South Indian Lake was divided into three categories based on the lifestyle patterns of its residents. These categories are: a traditional economy based on hunting, fishing and trapping, a wage economy based on work for wages, and an economy based on government payments in the form of family allowances, old age pensions and social assistance. Tables 8-21 and 8-22 provide a summary of the economy and the economic lifestyle of South Indian Lake in 1972.

In 1972, the community income of South Indian Lake was $543,800 while the average income per person in the labour force was $4,209 (excludes income of temporary residents such as teachers and nurses). Fishing provided $235,100 (43 percent) of community income; trapping $21,000 (4 percent); hunting $41,000 (8 percent); forestry $17,500 (3 percent); construction $25,300 (5 percent); service industries $20,000 (4 percent); and government $183,200 (33 percent). The government payments consisted of $35,000 in wages and $148,200 in transfer payments.

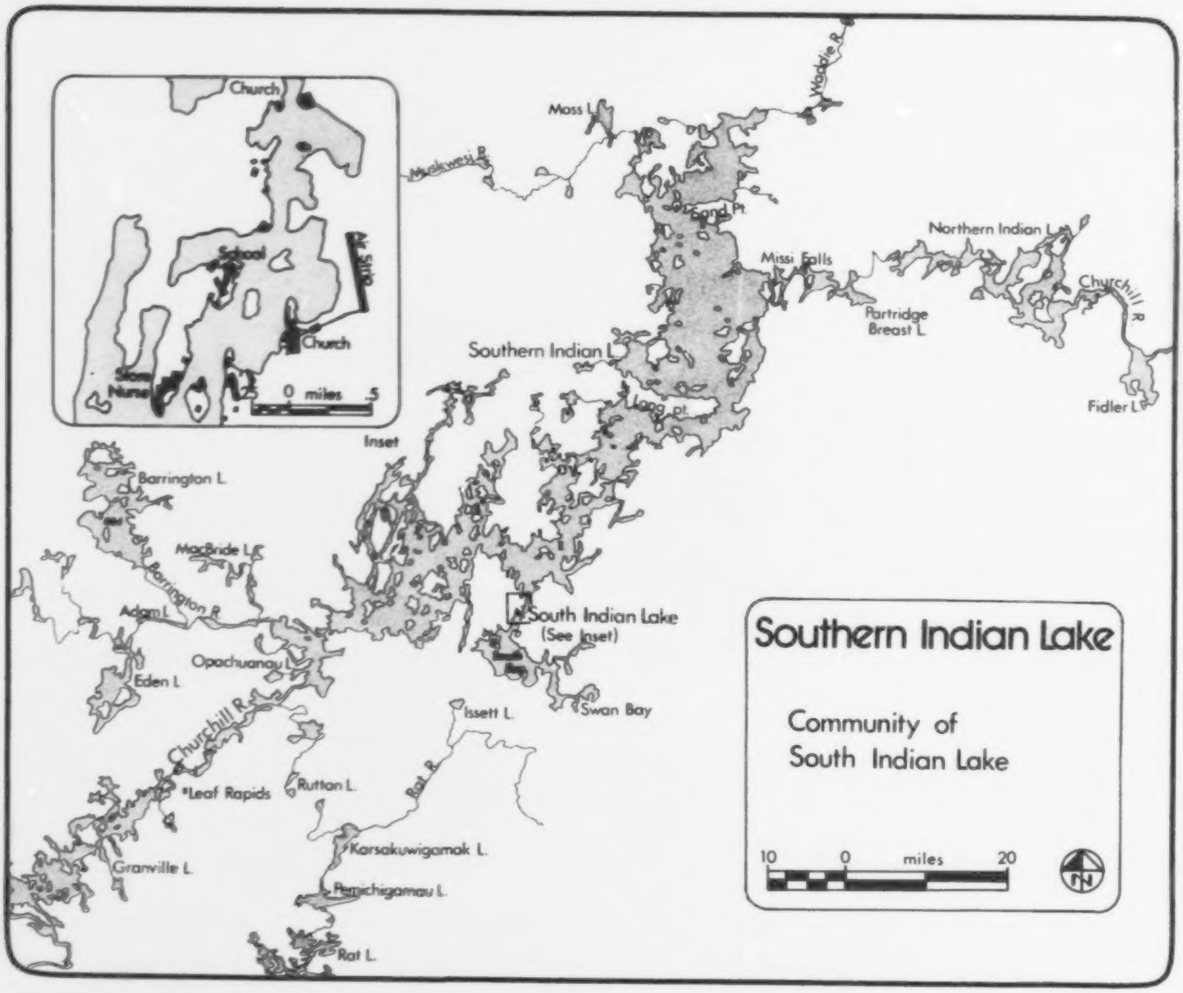

Southern Indian Lake
Community of
South Indian Lake
10
0
miles
20
N
Church
School
Air Strip
Church
Store
Nurse
0
miles
.5
Inset
Moss L.
Muskwesi R.
Waddie R.
Sand Pt.
Northern Indian L.
Missi Falls
Churchill R.
Partridge Breast L.
Fidler L.
Southern Indian L.
Long pt.
Barrington L.
MacBride L.
Barrington R.
Adam L.
South Indian Lake
(See Inset)
Opachuanau L.
Eden L.
Churchill R.
Swan Bay
Issett L.
Leaf Rapids
Ruttan L.
Rat R.
Granville L.
Karsakuwigamak L.
Pemichigamau L.
Rat L.

Fig. 8-16. Settled Areas of South Indian Lake, 1973.

Eighteen percent of community income derived from traditional sources was received in the form of cash and 19 percent in the form of income in kind (Table 8-22). Thirty-six percent was in the form of wage and salaries and 27 percent was in the form of government transfer payments. Fishing and government payments combined, provided 76 percent of the community income.

## TABLE 8-21
## SOUTH INDIAN LAKE ESTIMATED INCOMES DERIVED FROM ALL SOURCES, 1972

| | TRADITIONAL ECONOMY | | | | |
|---|---|---|---|---|---|
| INCOME SOURCE | Cash | Income-in-Kind | WAGE ECONOMY | TRANSFER PAYMENT ECONOMY | TOTAL |
| FISHING | $85,000 | 36,400 | 113,700 | - | $235,100 |
| TRAPPING | 11,600 | 10,000 | - | - | 21,600 |
| HUNTING | - | 41,100 | - | - | 41,100 |
| FORESTRY | - | 17,500 | - | - | 17,500 |
| CONSTRUCTION | - | - | 25,300 | - | 25,300 |
| GOVERNMENT | - | - | 35,000 | 148,200 | 183,200 |
| SERVICE INDUSTRIES | - | - | 20,000 | - | 20,000 |
| TOTAL | $96,600 | $105,000 | $194,000 | $148,200 | $543,800 |

## TABLE 8-22
## SOUTH INDIAN LAKE PERCENTAGE OF INCOMES DERIVED FROM ALL SOURCES, 1972

| | TRADITIONAL ECONOMY | | | | |
|---|---|---|---|---|---|
| INCOME SOURCE | Cash | Income-in-Kind | WAGE ECONOMY | TRANSFER PAYMENT ECONOMY | TOTAL |
| FISHING | 16 | 6 | 21 | | 43% |
| TRAPPING | 2 | 2 | | | 4% |
| HUNTING | | 8 | | | 8% |
| FORESTRY | | 3 | | | 3% |
| CONSTRUCTION | | | 5 | | 5% |
| GOVERNMENT | | | 6 | 27 | 33% |
| SERVICE INDUSTRIES | | | 4 | | 4% |
| TOTAL | 18% | 19% | 36% | 27% | 100% |

## EFFECT ON THE ECONOMY

Effect on Fisheries - In 1972, the commercial fishery provided 43 percent of the total community income when income in kind is added to profits and wages. It was the single most important source of livelihood in the community. The fishery provided $85,000 in net income to fishermen and $30,000 to hired men who worked for fishermen giving a total income of $115,000 from fishing. In addition, the fishery provided $84,000 in wages to those involved in packing and transporting the fish and $36,400 in income in kind from the use of fish for domestic purposes.

The increase in water level of Southern Indian Lake associated with the diversion project may affect the volume of fish harvested by decreasing the efficiency of fishermen and by increasing the hazard to fishermen imposed by floating debris. The biological productivity of the lake is expected to decrease by 10 percent. The annual quota set for the lake, taken to be the current biological production of the lake, is 1,200,000 lb. Thus, a 10 percent loss in the biological productivity could result in a reduction of potential production by 120,000 lb. However, the commercial catch over the past 4 years has been between 200,000 and 250,000 lb below the quota. This suggests that unless fishing activities increase, a decrease in the biological production will not reduce the volume of fish harvested. However, the effect of floating debris on fishing activities and hence on fish harvests will likely mean that fewer fish will be harvested. In addition, fish migration patterns may be altered, causing short-term production losses since the fishermen will have to find new fishing areas. A simulation model of the fishery was prepared to evaluate the effect of the above changes on the earnings of fishermen and wages paid by the South Indian Lake Co-op Fisheries Ltd. The results of the simulation are outlined in Table 8-23. As indicated, the potential reduction could be $12,600 (the loss resulting from a reduction in harvest from 1,120,000 to 1,000,000 lb).

Effect on Trapping - Trapping represents approximately 4 percent of the community's income source. From 1967-68 to 1971-72, the average number of people engaged in trapping was 114. The average net annual income to trappers was $14,112 (Table 8-24) with an additional $10,000 (1972) in the form of income in kind.

At present, an average of 65 percent of the value of the fur harvested comes from beaver and muskrat. These furbearers are water based and will be significantly affected by water regime changes. The projected losses in biological production by

## TABLE 8-23
## SOUTH INDIAN LAKE ESTIMATES OF FISHERY INCOME BY PRODUCTION LEVEL

| HARVEST | TOTAL FISHERMEN EARNINGS | CO-OP WAGES | TOTAL |
|---|---|---|---|
| 600,000 | 66,000 | 84,800 | 150,800 |
| 1,000,000 | 104,000 | 91,800 | 195,800 |
| 1,120,000[1] | 114,400 | 94,000 | 208,400 |
| 2,000,000 | 198,700 | 116,000 | 314,700 |

[1] *Actual production and income 1972/73 fishing seasons.*

## TABLE 8-24
## SOUTH INDIAN LAKE VALUE OF FUR HARVEST AND NUMBER OF TRAPPERS, 1967/68 to 1971/72

| YEAR | TOTAL VALUE[1] | NET VALUE[2] | NUMBER OF TRAPPERS |
|---|---|---|---|
| 1967/68 | $40,900 | $16,360 | 123 |
| 1968/69 | 46,700 | 18,680 | 114 |
| 1969/70 | 30,600 | 12,360 | 128 |
| 1970/71 | 28,800 | 11,520 | 113 |
| 1971/72 | 29,100 | 11,640 | 94 |
| Average Values | $35,300 | $14,112 | 114 |

[1] *Market Value F.O.B. Winnipeg.*

[2] *Net income to the trapper after production and marketing costs.*

*Source: Manitoba Department of Mines, Resources and Environmental Management.*

species indicates that beaver production could decline by approximately 12 percent. Muskrat would experience a similar drop but the economic implications are expected to be less significant as this species is of marginal commercial value. Lynx and mink may also decline but to a lesser degree.

Approximately twenty-two trapping blocks will be affected by the diversion. Registered trapping blocks 1, 2, 4, 22, 24, 33, 35 and 54 are expected to be most significantly affected. In addition, some blocks presently not trapped will also be affected, thus resulting in a loss of potential production. Over the period, 1967-68 to 1971-72, an average of sixty-eight trappers were employed in these trapping blocks. Over this same period, average net income to trappers totalled about $10,000 and average gross value totalled $25,000. This potential loss represents 70 percent of the total value of fur harvested and 59 percent of the total number of trappers in the community (Table 8-25).

TABLE 8-25
SOUTH INDIAN LAKE VALUE OF FUR HARVEST AND NUMBER OF TRAPPERS ON AFFECTED TRAPPING BLOCKS COMPARED WITH TOTAL HARVEST[1] AND TOTAL NUMBER OF TRAPPERS

| YEAR | GROSS VALUE OF FUR | NET VALUE | PERCENT OF TOTAL VALUE | NUMBER OF TRAPPERS AFFECTED | PERCENT OF TOTAL TRAPPERS |
|---|---|---|---|---|---|
| 1967/68 | $32,400 | $12,960 | 79 | 73 | 59 |
| 1968/69 | 30,000 | 12,000 | 64 | 61 | 54 |
| 1969/70 | 20,300 | 8,120 | 66 | 78 | 61 |
| 1970/71 | 22,100 | 8,840 | 76 | 68 | 60 |
| 1971/72 | 19,800 | 7,920 | 68 | 60 | 63 |
| Average | $24,920 | $ 9,968 | 70 | 68 | 59 |

[1] *Table 8-24*

*Source:* *Manitoba Department of Mines, Resources and Environmental Management.*

Effect on Hunting - A substantial portion of the food supply of the community is obtained from hunting moose and waterfowl. Moose hunting provides $34,100 in income in kind to the community in the form of meat ($30,000) and hides ($4,100). After diversion there will be a decrease in the moose populations in the area owing to the rise in water levels and resulting decrease of browse on the shorelines. Increased hunting pressure from Leaf Rapids residents and from construction workers is expected to add to the reduction in populations. The total value of waterfowl to the community is estimated at $7,000. The effect of the new water regime on the income in kind derived from waterfowl is not known at present.

Effect on Local Forestry Activities - Manitoba Hydro is planning an ongoing timber clearing program which will employ local residents. At the present time, an area surrounding the community and areas surrounding the fish packing stations (Camp 3, 6 and 9, Loon Narrows and the north end) are to be cleared. Nearly all homes in South Indian Lake are heated by wood. Timber from clearing operations near the community should be made available to community residents for use as fuel.

Effect on Construction Activities - Income from construction employment amounted to $25,300 or 5 percent of community income in 1972. At that time, five residents were employed with Manitoba Hydro and two residents with Sherritt Gordon Mines Limited at Leaf Rapids. Since then a large number (exact figures are not available) of South Indian Lake residents have been employed at the South Bay construction site. Construction activities at Missi Falls, South Bay and Notigi are expected to generate employment until the end of 1975. However, while many jobs are available, there is little evidence of local people acquiring transferable construction skills. Following this intense construction activity there will be a few long-term but seasonal job opportunities available under Manitoba Hydro's reservoir management program.

Effect on Service Industries - Local, private, service industries are minimal. The Hudson's Bay Company is the major retail outlet; it employs a housekeeper and four to five clerks with an annual wage bill of approximately $20,000. Although the diversion project may result in a greater community income it is not expected that many new service jobs will be created in the community as a result of the increased expenditures.

Government services have increased dramatically in recent years. Ongoing services such as health, telephone, education and local administration provide approximately fifteen jobs with an annual wage bill of $35,000. A large number of short-term construction jobs have been generated by development of the new town centre and new housing construction.

THE LABOUR FORCE - The community labour force numbers approximately 129 (men in the community between fifteen and sixty-five years of age who are not attending school). The mobility of this labour force is generally constrained by the same factors discussed in previous chapters on labour force. In addition, two further constraints can be identified. Firstly, there has been a briefer history of encounters with outside wage employment. Secondly, and perhaps related to the first point, there appears to be less willingness to relocate for the purpose of finding wage employment. Of the ninety who have some mobility, only ten have stated that they are willing to relocate if they receive vocational training.

A combination of fishing, trapping and working for wages is the means of earning an income for approximately one-half of the labour force while about one-third earn their income from wages only. Most of the community labour force is employed in the fishery. During the fishing season up to 110 men are involved in fishing and up to twenty-two men work at the lakeside operation. In addition, with the new packing plant at Leaf Rapids, there are at least fifteen men working in the plant, the dining hall, and transporting the fish.

The labour force is employed for 54 percent of the year while the remaining 46 percent is spent in unemployment or at subsistence activities (hunting and fishing for food and cutting wood for fuel). Approximately one-half are employed less than 30 weeks and approximately three-quarters are employed for less than 40 weeks. Only 17 percent of the labour force work full time.

EFFECT ON THE LABOUR FORCE - The diversion project is making available large numbers of short-term construction jobs to northern residents. The present high level of jobs related to the diversion project is expected to decrease rapidly after 1975. There is little evidence that local residents are acquiring construction skills in their present jobs; the majority being employed as labourers. The rapid decline in jobs, coupled with an increase in the local labour force of approximately 50 percent by 1980, indicates a pressing need for the development of a local employment strategy.

Such developments as the South Indian Lake town centre and increased activity at the South Bay diversion channel site have provided considerable wage employment. However, the resulting increase in community income has been partly offset by reduced activity in the traditional sector. An indication of this is the shift of local manpower from fish packing and fishing activities to the better paying construction jobs. This factor has contributed to a substantial reduction in summer fishing activity in the area.

The fishery will continue to be viable from a biological production point of view. However, future job opportunities in the fishery will depend upon the degree of rationalization, management competence and local initiative which is forthcoming. The other major traditional sector, trapping, is expected to continue to provide subsistence levels of income to some local residents. In addition to these traditional pursuits, development of programs to take advantage of job opportunities at Leaf Rapids could provide substantial levels of local employment. A willingness to relocate at least on a temporary basis, would be required. The construction of an all-weather road link between the community and the South Bay access road would facilitate local labour force mobility as well as provide jobs in construction and ongoing maintenance.

GOVERNMENT TRANSFER PAYMENTS - South Indian Lake received $148,200 in government transfer payments during the period April, 1972, to March, 1973. These payments were in the form of social assistance, family allowance and old age pensions. Social assistance accounted for $84,000; and of this, $72,765 went to Registered Indians while $11,252 went to non-Registered people. Family allowances accounted for $27,200 and old age pensions for $37,000.

It has been generally assumed that, unlike other remote native communities in northern Manitoba, South Indian Lake is a self sufficient community. Contrary to this misconception, an analysis of the per capita social assistance payments to Registered Indian residents in South Indian Lake and a comparison of such payments with those of other communities, indicates that South Indian Lake has the fourth highest per capita social assistance payments among fourteen remote communities located in northern Manitoba. Fifty-seven percent of the Registered Indians receive some social assistance each month. Registered Indian residents receive per capita social assistance payments of $185 per year while the non-Registered residents receive assistance amounting to $59 per capita per year.

EFFECT ON GOVERNMENT TRANSFER PAYMENTS - Transfer payments are expected to increase as employment on the Churchill River diversion project subsides and as more people enter the labour force and are unable to find employment. Further, if the traditional activities such as fishing and trapping are negatively affected, employment will be severely limited. This will result in a substantial increase in the input of government assistance to the community.

COMMUNITY INFRASTRUCTURE - At present there are two retail stores, one school, a nursing station, two churches and government administrative buildings. Recreational facilities include a community hall which can be used for movies or bingo and a sports field. Police services are limited to visits by the Royal Canadian Mounted Police. The community now has telephone and television service as well as electrical power.

Since parts of the community are separated by water, much of the intra-community transportation is over the lake. Transportation of school children is provided by boat during open water and by snowmobile during winter. External transportation services are provided by air, water and winter road. An airstrip is maintained by the Manitoba Department of Northern Affairs. Fish, groceries and materials are freighted by the local Fishermen's Co-op. A winter truck road runs from South Bay to the community.

Ground water is unavailable at the community and reliance is placed solely on Southern Indian Lake as a water supply source. Residents draw water directly from the lake by manual means; that is, water is drawn in a pail near the shoreline under open water conditions and through the ice in winter. Results of water quality analyses indicate that the water from Southern Indian Lake has excellent physical, chemical and microbiological characteristics apart from turbidity, particularly in the near shore waters. Local shoreline contamination, however, renders the water unacceptable as a domestic water supply without prior treatment.

Residents are primarily dependent upon privies for sewage disposal. Sanitary measures are often poor and wastes, either directly or indirectly, enter the water creating contamination near the shore.

EFFECT ON COMMUNITY INFRASTRUCTURE - The expected increases in water levels will result in substantial real property damages in the community of South Indian Lake. There are twelve buildings located below elevation 850, twenty buildings located between 850 and 855 and an additional thirteen buildings between elevations 855 and 860. Those structures located below elevation 850 can be expected to be damaged by the increase in water level. Those structures between 850 and 860 may be endangered in the future by the increased rate of shoreline erosion and slumpage. Some of these buildings can be moved while others will be abandoned. The nursing station and some buildings near the present school are mobile units which can be relocated. Two of the community's cemeteries will also suffer from erosion if not protected.

In anticipation of raised levels, work has been underway on new housing, and a community centre including school, store, nursing station and recreation facilities to replace those buildings and facilities that are being abandoned. Approximately twenty new homes were constructed in 1974. It is expected that thirty to fifty additional homes will be constructed in the summer of 1975. Areas which are beyond foreseeable effects of raised water levels, erosion and sliding were identified by Manitoba Hydro. All new structures are being built at or above elevation 860.

Changes in water level and flow will affect internal transportation and communication between parts of the community. The substantial increase in flow will have an effect on summer boat travel. Until the residents adjust to this new situation, precautions must be taken. The development of large back eddies in the bays may lead to an accumulation of floating logs and other debris. It is expected that there will be no safe ice crossings within 4 miles north and south of the community. This will result in severe disruption of local transportation patterns, particularly in the case of travel to and from the Hudson's Bay Company store, the nursing station, the school and other necessary services. The lack of safe ice cover may make it necessary to have the whole community on one side of the narrows. A new townsite is presently under development on the east side of the narrows and it is expected that most of the forty structures on the west side will be relocated in this area.

Transportation to and from the community will not be as severely affected. Higher summer water levels could create navigation hazards in the short run until boat operators become familiar with new landmarks associated with the new water regime. A substantial amount of debris is expected; this will increase the navigation hazard. With the exception of the immediate vicinity of the community, ice conditions are not expected to change. However, the winter road will require re-routing in the vicinity of the community. Trails to the domestic fishing area located north of the community will also require re-routing because of poor ice conditions. Three docks used by floatplanes and boats, and a number of smaller docks used by local boat owners will have to be raised.

The development of the community will see electric power extended throughout.

This will make available for the first time a pumped water supply. A waterworks system will provide easy access to treated water thus eliminating the requirement to draw untreated water directly from the lake. It is expected that the diversion of the Churchill River will result in increased turbidity at the location of the South Indian Lake community. The effect may be severe at the outset, moderating as the banks stabilize. Residents who draw domestic water by manual means will find the water less aesthetically pleasing. Suspended materials in water cause great difficulty in rendering it bacteriologically safe to drink. The operators of the community waterworks system will also have great difficulty in treating a water which is highly turbid.

A sewage system is being constructed to service the school, nursing station, store and hall. This will consist of a package sewage treatment plant (secondary treatment with effluent chlorination) with the effluent being discharged into the lake. The increased flow past the community should, however, lessen local shoreline contamination as well as the effect of objectionable constituents in the effluent from the sewage treatment plant.

OTHER STRUCTURES ALONG SOUTHERN INDIAN LAKE - In addition to the community shoreline property, other structures along Southern Indian Lake include fish stations, cabins, campsites and docks. There are approximately 100 structures excluding docks which are related to commercial fishing activity on the lake. The fish stations generally comprise a fish house for handling the catch, an ice house for storage of lake ice, and accommodation for the fishermen and their families during the season. In addition, there are four trappers' cabins located in the area.

EFFECT ON OTHER STRUCTURES ALONG SOUTHERN INDIAN LAKE - In the area there are fifty-one structures mostly fish houses and ice houses, below elevation 850. These structures will be affected by the initial rise in water levels. Furthermore, there are eighteen structures between elevations 850 and 855 and ten structures between elevations 855 and 860 which may be affected by future erosion and slumpage.

Many of the structures appraised, however, will be past their useful life and collapsed or otherwise destroyed before they are inundated. Assuming no new structures are erected in areas to be inundated, actual damage to real property in the area will be much less than is outlined. Information concerning elevations of the trappers' cabins is not available. Therefore, conclusions cannot be stated as to the extent of damage to these structures.

The majority of log constructed docks in the area are replaced almost annually due to ice breakup in the spring. Floating docks are not expected to be damaged during the flooding.

SOCIAL SYSTEM - It used to be that the trader was the most important figure in the community with a number of influential family heads also providing leadership. However, since the mid 1960's a number of factors have initiated and accelerated a process of change in both the economic and social structures of the South Indian Lake community. Some of these factors include: the application of The Northern Affairs Department Act; the development of mining complexes at Thompson and Leaf Rapids; the increasing accessibility by means of winter roads, airstrips and scheduled air flights; the commercialization of the fishery; the disappearance of the independent trader; the development of the Cranberry Portage High School; the increased level of government programs and services; and the Churchill River diversion project. In response to this process of change, economic and social structures become more complex. Family influences have been weakened by the increasing complexity of life. An elected mayor and community council have replaced the trader as the primary intermediary between the community and the world outside. The leadership base has broadened substantially to perform the functions required in carrying on the business and pleasure of day-to-day living. Each of the components of the present power structure provide some form of leadership (Fig. 8-17). Generally, those in the higher echelons of the power structure wield influence beyond the realm of the specific task they perform, whereas the leadership and influence of those in the lower echelons is more confined.

EFFECT ON THE SOCIAL SYSTEM - The social system of South Indian Lake has undergone a process of change in recent years and the effect of the diversion project is to accelerate these changes. The community has received information on the project from a variety of sources, including local newsletters, radio, meetings with government agencies, Manitoba Hydro, community council and the local flood committee. A few of the leaders have a fairly good idea as to how the diversion will work and therefore some idea of the changes it will bring to the community. However, it is apparent that the community in general does not really know what will happen.

There has been a considerable increase in social stress. This originally resulted from the uncertainty surrounding the decision to proceed with the diversion project with its associated impacts, as well as the legal and political

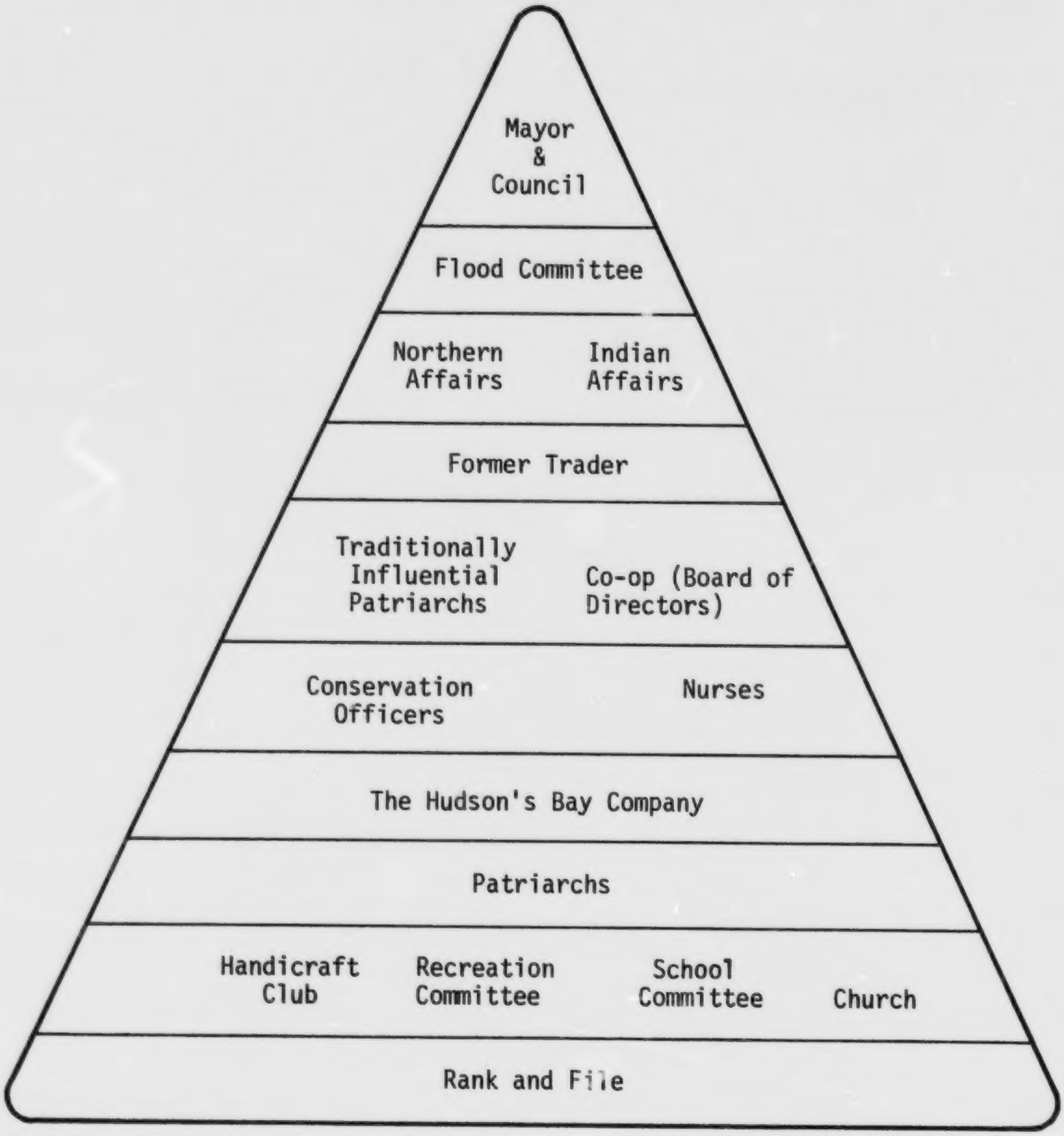

Mayor
&
Council
Flood Committee
Northern Affairs
Indian Affairs
Former Trader
Traditionally Influential Patriarchs
Co-op (Board of Directors)
Conservation Officers
Nurses
The Hudson's Bay Company
Patriarchs
Handicraft Club
Recreation Committee
School Committee
Church
Rank and File

Fig. 8-17. South Indian Lake Community Social System, 1974.

controversy connected with this issue. More recently, there have been demands for more rapid and effective decision-making which have become essential to deal with a number of issues related to the relocation of homes and the development of a new town centre. These demands on decision-making have seriously disrupted the traditional consensus decision-making pattern, thus contributing to a heightened level of social stress. It is difficult at this time for the community council to alter their traditional process unless formal community discussions take place concerning the roles of the community and the roles of the council in the process of new decision-making, problem-solving, communications and community life skills.

## LEAF RAPIDS AND RUTTAN LAKE

Leaf Rapids is a townsite established by the Manitoba Government located at the intersection of Provincial Road 391 and the Ruttan mine road. The population of the townsite at present is approximately 2400. Ruttan Lake is the site of a mining operation of Sherritt Gordon Mines Limited located some 10 to 15 miles east of Leaf Rapids.

The effect of changes in water level and flow resulting from the Churchill River diversion on community water supply and sewage disposal were examined. The water quality, intake and pumphouse structures at Leaf Rapids will not be affected by the diversion. The drain tributary into which Leaf Rapids townsite sewage enters will have a higher level following diversion of the Churchill River. This will affect the dilution/dispersion characteristics of the effluent as it mixes with the Churchill River water. This may have some significance depending on the use to which this reach of the Churchill River is to be put. The operation of water and waste disposal systems at Ruttan Lake will also be unaffected.

# SUGGESTED MEASURES FOR THE SOUTHERN INDIAN LAKE AREA TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE CHURCHILL RIVER DIVERSION PROJECT

During the course of their investigations in the Southern Indian Lake area, contracting agencies suggested ways to lessen the detrimental effects and to enhance the overall benefits of the Churchill River diversion project. Some of these suggestions were examined in depth and the results along with recommendations for action, were reported by the Study Board to the ministers. However, time and funding constraints prohibited investigation of all suggestions in detail. These measures have been assessed according to whether they will mitigate or enhance effects of the diversion project. The results, presented in Table 8-26, will serve as a rough guide to those responsible for examining enhancement and mitigation measures.

TABLE 8-26
SUGGESTED MEASURES FOR SOUTHERN INDIAN LAKE TO MITIGATE THE DETRIMENTAL EFFECTS AND TO ENHANCE THE BENEFITS OF THE CHURCHILL RIVER DIVERSION PROJECT

| | ● Fish Populations | ○ Efficiency of Harvesting | ● Wildlife Populations | ○ Efficiency of Harvesting | ● Forest Resources | ○ Utilization of Forest Resources | ● Mineral Resources | ○ Utilization of Mineral Resources | ● Outdoor Recreation Resources | ○ Utilization of Outdoor Recreation Resources | ● Knowledge of prehistorical and historical cultures | ● Transportation - Navigation services and facilities | ○ Utilization of Trans-Nav: services and facilities | ● South Indian Lake Community Income | ● Employment of People from South Indian Lake | ● Maintain Traditional Life Styles at South Indian Lake | ● Efficiency of the Social System at South Indian Lake | ● Community Infrastructure at South Indian Lake | ● Efficiency of the Social System at Leaf Rapids |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Manitoba Hydro should make known the effects of the Churchill River Diversion to the residents of South Indian Lake and Leaf Rapds. | | | | | | | | | | | | | | | | | M | | M |
| *Hunting and fishing activities of construction workers be controlled if necessary to ensure stocks for local people traditionally dependent on these populations for sustenance. | | | | | | | | | | | | | | M | | | | | |
| *Following completion of construction activities, temporary buildings and camp debris should be removed. | | | | | | | | | M | | | | | | | | | | |
| *All campsites and construction areas should be cleared of refuse after removal of the camp and returned to as near natural condition as possible. | | | | | | | | | M | | | | | | | | | | |
| *Garbage from construction camps should be incinerated. | | | M | | | | | | M | | | | | | | | | | |
| Remove mature timber and provide shoreline access sites by clearing and grubbing strips 200 ft wide. | | M | | | | M | | | M | | | M | M | | | | | | |
| Relocate the community on the east side of the Narrows. | | | | | | | | | | | | | M | | M | | E | E | |
| Build an all-weather road to link the community with the South Bay access road. | | M | | | | E | | | | E | | E | E | | M | | | | |
| Prepare whitefish and cisco spawning beds. | M | | | | | | | | | | | | | | | | | | |
| Adequate funding be provided to allow complete excavation prior to flooding of Kame Hills sites which are below floodline. | | | | | | | | | | | M | | | | | | | | |
| Internal transportation facilities be provided to replace the loss of ice travel before the winter of 1975/76. | | | | | | | | | | | | | | | | | | M | |
| A water and ice monitoring program be established. | | | | | | | | | | | | | | | | | E | | |
| Losses in real property be compensated. | | | | | | | | | | | | | | | | | | M | |
| Water levels be regulated to speed re-establishment of shorelines and aquatic vegetation. | | | M | | | | | | | | | | | | | | | | |
| Clear to speed shoreline development in areas which show potential for becoming productive wildlife habitats. | | | M | | | | | | | | | | | | | | | | |
| Commence flooding in the last week of June or early July to minimize loss of nesting waterfowl, gulls and terns, and muskrats. | | | M | | | | | | | | | | | | | | | | |
| Clear islands to provide alternative nesting sites for gulls and terns. | | | M | | | | | | | | | | | | | | | | |
| Advise personnel to avoid harassment of all wildlife, especially gulls, terns, moose and nesting waterfowl. | | | M | | | | | | | | | | | | | | | | |
| Trapping losses should be compensated. | | | | | | | | | | | | | | M | | | | | |
| A fur management plan should be developed and implemented. | | | | M | | | | | | | | | | M | | M | | | |
| Clear all shoreline that is to be unundated in areas immediately adjacent to settlements and fish camps. | | | | | | | | | | | | | | | | M | | | |
| Fish populations and biological productivity be monitored and the necessary minimum annual discharge at Missi Falls be determined to maintain fish populations and productivity at an acceptable level. | M | M | | | | | | | | | | | | | | M | | | |
| Boom floating debris and mark all newly created navigational hazards. | | M | | | | | | | | M | | M | M | | | M | | | |

LEGEND

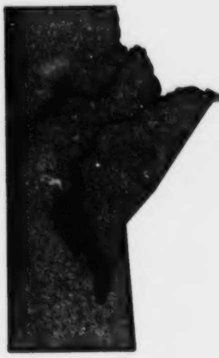
M The suggested measure has the potential to cause the factor to approach the state it was prior to the Churchill River Diversion.

E The suggested measure has the potential to increase the factor to a state greater than it was prior to the Churchill River Diversion.

* Measures recommended to the Ministers during the course of the Study

# FOOTNOTES

[8-1] Rowe, J.S. 1959. Forest Regions of Canada. Department of Northern Affairs and Natural Resources. Forestry Branch Bulletin 123.



# chapter 9

# area 5
lower churchill river

## GEOGRAPHY

### LOCATION

The lower Churchill River area comprises that portion of the Churchill River from Missi Falls, the outlet of Southern Indian Lake, to Hudson Bay. Contained within this study area are the four riverine lakes on the lower Churchill River, Partridge Breast, Northern Indian, Fidler and Billard, and the Churchill River estuary (Fig. 9-1).

### CLIMATE

The lower Churchill River area lies within a subarctic climate region with short, cool summers and cold, snowy winters. Average temperatures in January and July are -18°F and 56°F respectively.

The average frost free season varies from 60 days at Churchill to 80 days at Southern Indian Lake.

Average annual snowfall at Churchill is 50 to 55 inches and somewhat lower, 40 to 45 inches, near Southern Indian Lake. Churchill, however, receives 3 inches less total precipitation (14 inches total) throughout the year than does the southwest portion of the lower Churchill River area.

The lower Churchill River falls mainly within the zone of discontinuous permafrost.

Winter (mean daily temperatures lower than 32°F) in the northeast half of the Tower Churchill area lasts 2 to 4 weeks longer and summer (mean daily temperatures higher than 42°F) is 2 to 4 weeks shorter than in the southwest half of this study area.

## PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL

From Southern Indian Lake to within 90 miles of Hudson Bay, the Churchill River flows over granites and granitic gneisses of the Canadian shield. For the last third of its length it flows over Paleozoic limestone, and enters Hudson Bay after flowing over a narrow band of Precambrian sandstone.

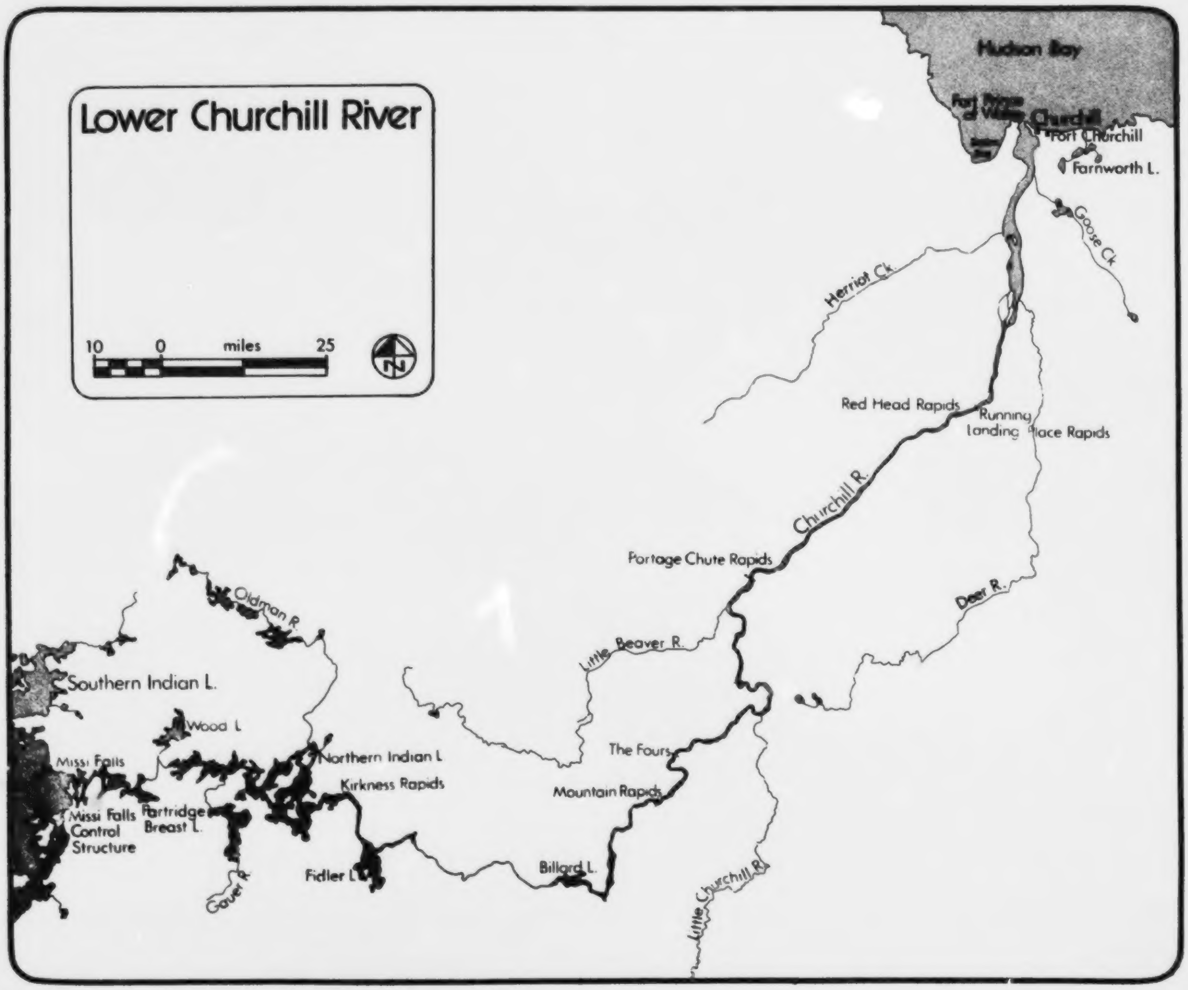

Lower Churchill River
10
0
miles
25
N
Hudson Bay
Churchill
Fort Churchill
Farnworth L.
Goose Ck
Herriot Ck
Red Head Rapids
Running Landing Place Rapids
Churchill R.
Portage Chute Rapids
Deer R.
Oldman R.
Little Beaver R.
Southern Indian L.
Wood L.
Missi Falls
Northern Indian L.
Kirkness Rapids
The Fours
Mountain Rapids
Missi Falls Control Structure
Partridge Breast L.
Fidler L.
Billard L.
Gauer R.
Little Churchill R.

Fig. 9-1. Lower Churchill River Area

Generally, the river channel is controlled by the underlying bedrock in both the horizontal and vertical planes, but control is mainly vertical in the easterly portion.

Overburden is generally thick, up to 100 ft in some areas, and overall relief is generally low. From Missi Falls to a point approximately 20 miles east of Billard Lake, the relief is generally bedrock-controlled with an extensive drift mantle. From this point to within 30 miles of Long Island, the river flows through hummocky disintegration moraine. The eastern edge of this moraine represents the former western limit of the Tyrrell Sea, a transgression of Hudson Bay following the retreat of the most recent glaciers. In the area of the estuary a continuous peat mantle with ice wedge polygons predominates. Around the river mouth there are recent alluvial and marine deposits.

Throughout the Canadian shield portion of the lower Churchill River area, small lakes and a varying peat mantle with muskeg are prevalent. In the Hudson Bay lowlands, a heavy peat mantle predominates, lakes are more numerous and permafrost is more prevalent.

## VEGETATION

The study area lies entirely within the subarctic belt described by Ritchie (1962).[9-1] The vegetation in this belt is primarily open coniferous forest or a mixture of forest and tundra.

Forests along the lower Churchill River are greatly influenced by the river. Trees are generally taller, and forests are denser for at least one mile from the river.

Ritchie (1962) has divided the lower Churchill River area into five vegetation zones (Table 9-1). These zones are identified as: Eastern Southern Indian Lake, Western Southern Indian Lake, Upper Churchill River, Silcox and Churchill River.

## DRAINAGE PATTERNS

The Churchill River system drains 115,000 square miles in Alberta, Saskatchewan and Manitoba. The drainage area of the lower Churchill River is about 14,500 square miles. Tributaries flow south to the Churchill River from within 50 miles of the Manitoba-Northwest Territories boundary.

TABLE 9-1

PHYSIOGRAPHIC REGIONS AND VEGETATION ZONES*

LOWER CHURCHILL RIVER, MANITOBA (SOUTHERN INDIAN LAKE - HUDSON BAY)

| REACH | Physiographic Region | Vegetation Zones | Length (Miles) | Description |
|---|---|---|---|---|
| (1) Missi Rapids-Partridge Breast Lake | PRECAMBRIAN SHIELD | EASTERN SOUTHERN INDIAN LAKE | 100 | Eastern Southern Indian Lake: black spruce predominate (closed forest and moss-muskeg). Jack pine is common on sand and gravel. Deciduous growth includes willow, alder, white birch, trembling aspen and balsam poplar. |
| (2) Partridge Breast Lake | | | | |
| (3) Partridge Breast Lake-Northern Indian Lake | | | | |
| (4) Northern Indian Lake | | WESTERN SOUTHERN INDIAN LAKE | 20 | Western Southern Indian Lake: black spruce predominates. Mixed forests of white spruce, balsam fir, balsam poplar and trembling aspen occur on alluvial deposits. Jack pine dominates ridges and sand plains. |
| (5) Northern Indian Lake-Fidler Lake | | UPPER CHURCHILL RIVER | | |
| (6) Fidler Lake | | | | |
| (7) Fidler Lake - Billard Lake | | | 105 | Upper Churchill River: Open black spruce muskeg on acid peat predominates. Low shrubs and mosses form secondary layer. Bogs are present in poorly drained sites and black spruce occupies heavy upland glacial material. Fire creates mixed forests of jack pine, white birch and trembling aspen. Continuous shrub communities along river courses are common. |
| (8) Billard Lake | | | | |
| (9) Billard Lake - Little Churchill River | | | | |
| (10) Little Churchill River - Portage Chute Rapids | HUDSON BAY LOWLANDS | | | |
| (11) Portage Chute Rapids - Red Head Rapids | | CHURCHILL RIVER<br>SILCOX | 15 | Silcox: continuous tracts of shrubby communities or moss muskeg. Occasionally, black spruce, larch fen, or jack pine are found. |
| (12) Red Head Rapids - Long Island | | | | |
| (13) Long Island - Mosquito Point | | | 60 | Churchill River: inland, peat deposits are dominated by lichen and moss muskeg (black spruce prevalent) and larch fens. Near the estuaries, there are stands of white spruce on alluvium, associated with marsh, shrub and larch. |
| (14) Mosquito Point - Mouth | | | | |

* *After Ritchie, 1962*

The river widens into several lakes from Missi Falls to Hudson Bay; these include Partridge Breast, Northern Indian, Fidler and Billard lakes. Total surface area of these lakes is approximately 100 square miles. Northern Indian Lake is the largest (67 square miles) and Billard Lake is the smallest (5 square miles).

| Lake | Mean Surface Elevation (Feet) | Surface Area (Sq. Miles) |
|---|---|---|
| Partridge Breast | 802.8 | 12 |
| Northern Indian | 772.8 | 67 |
| Fidler | 758.6 | 16 |
| Billard | 621.6 | 5 |

The tributaries of the lower Churchill River include the Little Churchill River, the Little Beaver River, the Deer River and the Gauer River. These tributaries drain a relatively small area, and contribute less than 10 percent of the total flow at the mouth of the Churchill River.

## HUMAN HABITATION

Churchill is the only community in the lower Churchill River area. However, Ilford, a small community located on the Canadian National Railways' Hudson Bay branch line about 90 miles east-northeast of Thompson, will be affected by changes to the lower Churchill River.

Churchill is located at the mouth of the Churchill River at Hudson Bay. Its population is approximately 3500 of which 50 percent is under age 15. Its major economic activities are marine transport, local services and government administration. This community differs substantially from those discussed earlier in this report in that traditional native pursuits such as hunting, trapping and fishing are not an important source of employment and subsistence income. Churchill is served by air, rail and sea transportation. The community has an elaborate road network connecting its four elements, Fort Churchill, Dene Village, Akudlik and the main Churchill townsite. A federal-provincial redevelopment program is underway to consolidate these elements and to provide improved municipal services. The airport is fully equipped for instrument landings; the Canadian National Railways' Hudson Bay branch line offers a rail link south; a floatplane base is located at nearby Farnsworth Lake; and seaport facilities serve ocean freighters and coastal resupply vessels. The port's main commodity is prairie grain destined for Europe, but such commodities as sulphur are also becoming important. The National Harbours Board is undertaking an extensive program to improve the port's facilities.

Ilford, a predominantly non-Registered Indian community of about 200, is located outside the lower Churchill River area but could experience considerable economic hardship as a result of disruptions to the commercial fishery on Partridge Breast Lake, Northern Indian Lake, Fidler Lake and Billard Lake. The economy of the community centres around fishing, the railway and transportation services, and to a minor extent, trapping. The Ilford Co-operative Limited has derived approximately 40 percent of its fish production which makes up 30 percent of the landed value from the lower Churchill River lakes.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE PHYSICAL ENVIRONMENT

## WATER REGIME CHANGES

The changes in the water regime of the lower Churchill River will depend on the pattern of flow release through the Missi Falls control structure. These changes have been computed based on the following information for the hydrologic base period 1928 to 1966:

- modified historic mean monthly flows at Missi Falls, the outlet of Southern Indian Lake, computed by Manitoba Hydro from data supplied by the Saskatchewan-Nelson Basin Board (SNBB);
- mean monthly local runoff between Missi Falls and the Churchill River estuary, computed by the SNBB;
- post-diversion mean monthly discharges at Missi Falls, compiled by Manitoba Hydro; and
- water level - discharge relationships developed by the Water Resources Branch Manitoba Department of Mines, Resources & Environmental Management, for the four lower Churchill River lakes (Partridge Breast, Northern Indian, Fidler and Billard).

The modified historic flows are tabulated in Table 9-2 and the post-diversion flows in Table 9-3. The water level changes in the four lower Churchill River lakes are summarized in Table 9-4. The mean monthly levels for the modified historic and post-diversion conditions are illustrated in Figure 9-2 (Partridge Breast Lake), Figure 9-3 (Northern Indian Lake), Figure 9-4 (Fidler Lake), and Figure 9-5 (Billard Lake).

Under modified historic conditions the average flow in the lower Churchill River is approximately 35,700 cubic feet per second (cfs) at Missi Falls and 39,900 cfs at the estuary. Mean monthly flows vary between approximately 22,500 cfs and 83,100 cfs at Missi Falls, and between about 22,800 cfs and 98,800 cfs at the mouth of the river.

The Churchill River diversion licence permits Manitoba Hydro to reduce the Churchill River flows at Missi Falls to a minimum of 500 cfs in summer and 1500 cfs in winter. With the Churchill River diversion project in operation, the average annual flow at Missi Falls will be reduced by about 75 percent, from 35,700 cfs to

TABLE 9-2

LOWER CHURCHILL RIVER MODIFIED HISTORIC MEAN MONTHLY FLOWS BELOW MISSI FALLS

Maximum Flows in cfs

| | JAN | FEB | MAR | APR | MAY | JUN | JULY | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Missi Falls | 51645 | 44609 | 35874 | 33902 | 44902 | 73906 | 83101 | 72334 | 66716 | 64164 | 59992 | 56430 | 83101 |
| Local Inflow | 2979 | 2615 | 2388 | 3480 | 24699 | 24858 | 14965 | 16011 | 13600 | 10257 | 5390 | 4162 | 24858 |
| Total Flow at Churchill | 54624 | 47224 | 38262 | 37382 | 69601 | 98764 | 98066 | 88345 | 80316 | 74421 | 65382 | 60592 | 98764 |

Average Flows in cfs

| | JAN | FEB | MAR | APR | MAY | JUN | JULY | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Missi Falls | 32164 | 29666 | 27906 | 27610 | 31037 | 38961 | 44143 | 44132 | 41861 | 38948 | 37105 | 34771 | 35692 |
| Local Inflow | 1433 | 1218 | 1065 | 1170 | 8491 | 10817 | 8113 | 5340 | 4817 | 3778 | 2797 | 1999 | 4253 |
| Total Flow at Churchill | 33597 | 30884 | 28971 | 28780 | 39528 | 49778 | 52256 | 49472 | 46678 | 42726 | 39902 | 36770 | 39945 |

Minimum Flows in cfs

| | JAN | FEB | MAR | APR | MAY | JUN | JULY | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Missi Falls | 24277 | 23200 | 23718 | 22493 | 22597 | 26151 | 28787 | 31070 | 29979 | 26422 | 25607 | 24905 | 22493 |
| Local Inflow | 368 | 343 | 307 | 337 | 2638 | 2092 | 637 | 1205 | 454 | 614 | 704 | 569 | 307 |
| Total Flow at Churchill | 24645 | 23543 | 24025 | 22830 | 25235 | 28243 | 29424 | 32275 | 30433 | 27036 | 26311 | 25474 | 22830 |

TABLE 9-3

LOWER CHURCHILL RIVER POST DIVERSION MEAN MONTHLY FLOWS BELOW MISSI FALLS

Maximum Flows in cfs

| | JAN | FEB | MAR | APR | MAY | JUN | JULY | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Missi Falls | 14957 | 6509 | 1500 | 13987 | 52437 | 73789 | 49893 | 40428 | 32001 | 34968 | 29021 | 21430 | 73789 |
| Local Inflow | 2979 | 2615 | 2388 | 3480 | 24699 | 24858 | 14965 | 16011 | 13600 | 10257 | 5390 | 4162 | 24858 |
| Total Flow at Churchill | 17936 | 9124 | 3888 | 17467 | 77136 | 98647 | 64858 | 56439 | 45601 | 45225 | 34411 | 25592 | 98647 |

Average Flows in cfs

| | JAN | FEB | MAR | APR | MAY | JUN | JULY | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Missi Falls | 2824 | 1906 | 1500 | 2025 | 10162 | 25409 | 18940 | 15204 | 8061 | 3504 | 6704 | 5051 | 8857 |
| Local Inflow | 1433 | 1218 | 1065 | 1170 | 8491 | 10817 | 8113 | 5340 | 4817 | 3778 | 2797 | 1999 | 4253 |
| Total Flow at Churchill | 4257 | 3124 | 2565 | 3195 | 18653 | 36226 | 27053 | 20544 | 12878 | 12282 | 9501 | 7050 | 13110 |

Minimum Flows in cfs

| | JAN | FEB | MAR | APR | MAY | JUN | JULY | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Missi Falls | 1500 | 1500 | 1500 | 1500 | 500 | 500 | 500 | 500 | 500 | 500 | 1500 | 1500 | 500 |
| Local Inflow | 368 | 343 | 307 | 337 | 2638 | 2092 | 637 | 1205 | 454 | 614 | 704 | 569 | 307 |
| Total Flow at Churchill | 1868 | 1843 | 1807 | 1837 | 3138 | 2592 | 1137 | 1705 | 954 | 1114 | 2204 | 2069 | 954 |

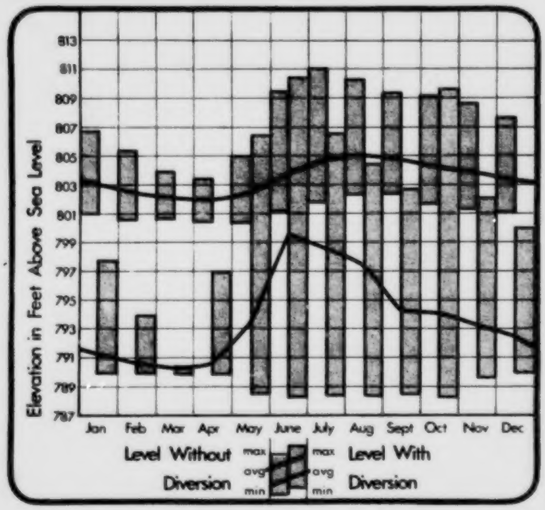


Fig. 9-2. Partridge Breast Lake Water Levels

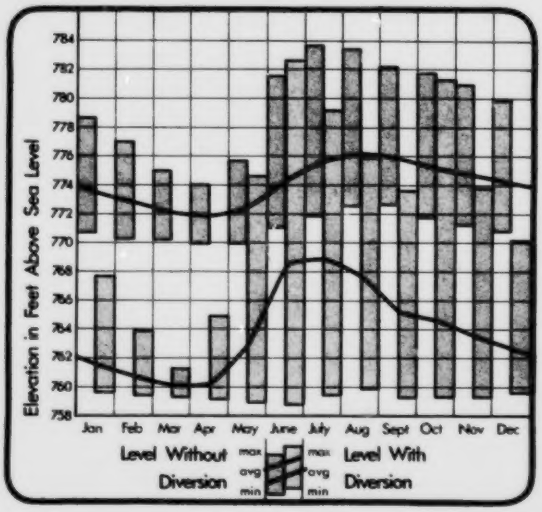


Fig. 9-3. Northern Indian Lake Water Levels

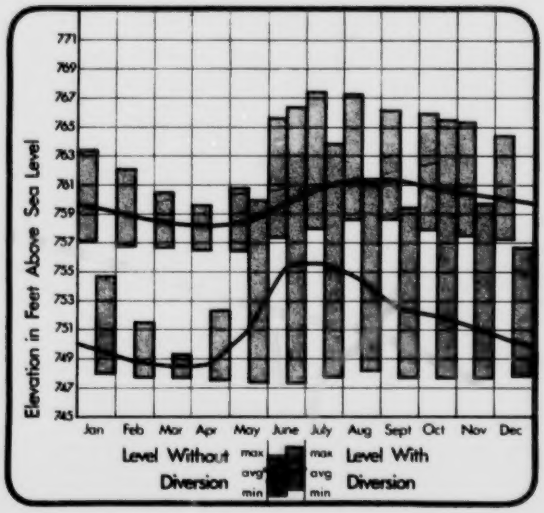


Fig. 9-4. Fidler Lake Water Levels

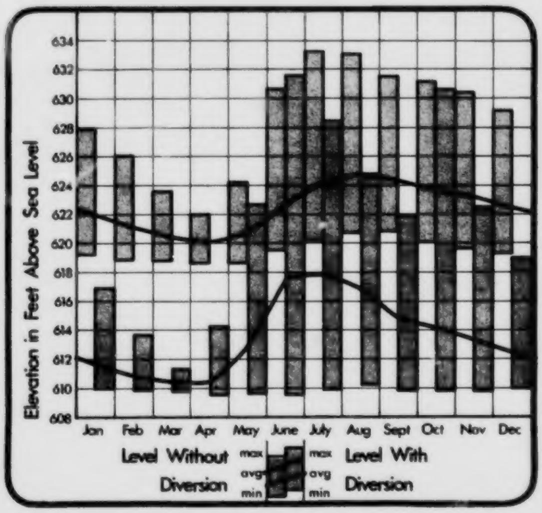


Fig. 9-5. Billard Lake Water Levels

TABLE 9-4
LOWER CHURCHILL RIVER LAKES MEAN MONTHLY WATER LEVELS

| | Post Diversion | Modified Historic | Change |
|---|---|---|---|
| Partridge Breast Lake | | | |
| Maximum | 810.6 ft | 811.2 ft | - 0.6 ft |
| Average | 793.7 | 803.5 | - 9.8 |
| Minimum | 788.4 | 800.4 | - 12.0 |
| Range of fluctuation | 22.2 | 10.8 | + 11.4 |
| Northern Indian Lake | | | |
| Maximum | 782.7 | 783.7 | - 1.0 |
| Average | 763.7 | 774.0 | - 10.3 |
| Minimum | 758.8 | 770.0 | - 11.2 |
| Range of fluctuation | 23.9 | 13.7 | + 10.2 |
| Fidler Lake | | | |
| Maximum | 766.4 | 767.4 | - 1.0 |
| Average | 751.2 | 759.6 | - 8.4 |
| Minimum | 747.2 | 756.4 | - 9.2 |
| Range of fluctuation | 19.2 | 11.0 | + 8.2 |
| Billard Lake | | | |
| Maximum | 631.8 | 633.3 | - 1.5 |
| Average | 613.6 | 622.6 | - 9.0 |
| Minimum | 609.6 | 618.7 | - 9.1 |
| Range of fluctuation | 22.2 | 14.6 | + 7.6 |

8900 cfs. The average annual flow at Churchill after diversion will be reduced by about 67 percent, dropping from 39,900 cfs to 13,100 cfs. The minimum flows in the lower Churchill River will be substantially lower in the post-diversion period, but the maximum flows will be only marginally lower (Tables 9-2 and 9-3). Therefore, the magnitude of the range between high and low flows will increase.

Although the magnitude of flow fluctuations is expected to increase, the annual pattern of fluctuation will not change substantially. Under natural conditions, levels and flows on the lower Churchill River generally peak in July and then decline gradually until the following year. After diversion, the peak levels and flows may occur a few weeks earlier but the same general pattern is expected.

As can be seen in Table 9-4, the four lakes on the lower Churchill River, Partridge Breast, Northern Indian, Fidler, and Billard, will on average all experience significant reductions in water level and surface area. The average water levels will be considerably lower and the range of fluctuation between minimum and maximum levels will be approximately twice that under modified historic conditions. Average water levels will be reduced by 8.4 to 10.3 ft on these lakes. Maximum mean monthly water levels will not change significantly. Anticipated maximum levels will be reduced by 0.6 to 1.5 ft. However, minimum mean monthly levels are expected to be 9.1 to 12.0 ft lower in the post-diversion period. Because of differences in the morphometry of the lakes, the anticipated reductions in average levels will reduce the surface area by varying amounts. The surface area of Partridge Breast will on average be reduced by 32 percent, Northern Indian by 44 percent, Fidler by 73 percent and Billard by 52 percent.

## ICE REGIME CHANGES

Gradually as the atmospheric temperature drops below freezing, border ice grows and spreads across a river channel and the amount of floating ice increases in quantity to such an extent that, in areas with relatively low velocities, ice bridges form. At this point the floating slush ice or cakes start to accumulate against the fixed cover. The ice cover progresses upstream at a rate which depends on the local flow velocity and size of the ice particles or cakes. The slush ice is usually drawn in under the cover and deposited a short distance downstream or accumulates on the surface against the cover.

Under present conditions with an early winter discharge of approximately 35,000 cfs, the flow velocity is comparatively high and along the complete length of the river there are only a few areas where ice bridges form. However, after the diversion, with reduced flow, the possibility of bridging will be greater. For example, the present flow velocities in the vicinity of Churchill's water intake prevent the formation of a cover until one has formed farther downstream and progressed upstream. In early winter all the floating ice moves downstream towards the harbour and is partially evacuated during the ebb tide. After the diversion, reduced discharges and the resulting lower flow velocities at the water intake would help the formation of an ice cover in this area in the early winter and arrest downstream movement of floating ice.

It is estimated that, after diversion, the process of ice cover formation will start around mid October, whereas at present it begins about 2 weeks later, early November. Subsequently, due to the loss of heat through the open areas and the upstream progression of the ice cover from the initial ice bridges, the river is completely covered by the first week of January under present conditions. After the diversion, similar cover formation will be attained about 3 weeks earlier.

After formation, the ice cover gradually thickens due to loss of heat through the ice. In areas where the initial cover is very thick, there is practically no further increase. This is generally the case all along the river except in lakes or other areas where velocities are low. At the end of the winter, the ice thickness in these relatively tranquil areas will attain 5 to 6 ft. The average ice thickness with a discharge of 35,000 cfs (present condition) is about 18 ft. With a discharge of 4000 cfs (post-diversion condition), the average ice thickness in the lower Churchill River will be approximately 9 ft, a reduction of 50 percent.

Ice generated during the formation of the cover is produced at the expense of the river discharge. In lakes or slowly moving waters this effect is negligible providing that there is no rapid rise in the lake level due to cover formation at the outlet. On the other hand, in the river, the ice cover formation is accompanied by an increase in water level, resulting from the obstruction to the flow section by the cover, and increased hydraulic roughness. The increase in water level causes some of the flow to go into storage; the quantity which goes into storage may be equal to the volume of the ice cover. For a discharge of 35,000 cfs, the flow reduction during the ice generation period has been calculated to be 3800 cfs. With a 4000 cfs discharge, the flow reduction would be 2200 cfs.

These figures are based on mean values of monthly temperature and average ice cover progression. There could be short periods of extreme low temperatures when the flow reduction might be greater. In terms of the present discharge regime these flow reductions represent only a small percentage of the total flow. However, under post-diversion conditions, the flow reductions will be almost equal to the flow remaining in the river. Under minimum winter flow releases of 1500 cfs from the Missi Falls control structure, it is anticipated that a major part of the flow section in the lower Churchill River will consist almost entirely of ice. Only a small discharge, about 100 cfs, would most probably reach the estuary flowing along the thalweg and between loose ice blocks.

Unless it is artifically induced by a premature increase in discharge at Missi Falls, the spring breakup, which depends essentially on atmospheric temperature, will occur at about the same time of the year as at present, mid June.

During the spring breakup the water levels are expected to be lower than those under present conditions. As a result, it is anticipated that in general the extent of spring flooding in the estuary will be much less than experienced in the past.

In an average year after diversion, the spring breakup levels will be considerably higher than those caused by the preceding midwinter cover conditions, typically 10 to 15 ft higher in lake and river sections and up to 40 ft higher in rapids sections. As the levels after spring breakup are expected to be lower than the levels during the period of spring breakup, it is certain that some ice-scoured shoreline will be maintained along the major portion of the river. However, the top levels of the ice-scoured zones will be lower than those under present conditions, and the widths less. During extreme flood conditions, the greater part of these scoured shorelines will most probably be submerged, but at the same time the preceding spring breakup flood levels will also have been higher than normal and will possibly have caused scouring even higher.

## CHANGES IN THE CHEMICAL, BACTERIOLOGICAL AND PHYSICAL PROPERTIES OF WATER

The lower Churchill River within 50 miles downstream of Missi Falls broadens into three sizable lakes, Partridge Breast, Northern Indian, and Fidler, before following a well defined river channel to Hudson Bay. The three lakes have a combined surface area of 80 square miles and mean depths ranging from 9.8 to 20.7 ft. Local drainage is a very small component of the hydrologic budget of these lakes. The high Churchill flows combined with the small volume of the lakes imposes a short exchange time on the water in the lakes, from 1.3 days for Fidler Lake to 9.0 days for Northern Indian Lake.

Lower flows will increase exchange times somewhat in the lakes, but the large reductions in volume will largely offset the lower discharges. After diversion, under average flow conditions, exchange times for the different lakes will range from 1.3 to 16.4 days as compared to 1.3 to 9.0 days as at present. The lakes will still be riverine in nature and the major chemical constituents will reflect discharge at Missi Falls.

It was previously predicted that there will be appreciable changes in the hydrography of Southern Indian Lake north of Long Point. Increases in total dissolved solids, dissolved inorganic carbon, calcium and magnesium are expected and the lower Churchill River lakes will reflect these changes.

The operation of the diversion will accentuate the fluctuation of flows at Missi Falls. At present the average summer maximum monthly flow (July) is less than twice as large as the average winter minimum monthly flow (March). After diversion, the average flow in July will be eleven times as large as the average March flow. Consequently the annual fluctuation in water level of the lakes will increase from a range of 4 to 5 ft up to 7 to 9 ft. Initially after the diversion goes into effect, broad widths of beach will be exposed. These will eventually be colonized by terrestrial plant communities, but a broad band around the reduced lakes will be maintained in a state of disequilibrium by the large fluctuation in water level. The lower water levels after diversion will lead to erosion by wave action of sediments deposited previous to diversion, and the eroded material will increase turbidity over large areas of the lake.

From the viewpoint of water supply for human consumption, the only user group is the community of Churchill. Treatment of water is currently confined to chlorination. The water quality changes most likely to be noticed are associated with colour and hardness. In neither case will the increase be harmful to the user, however, it may create public irritation. Treatment costs may rise marginally. The possibility of salt water intrusion into the intake of Churchill's water supply system is discussed in a later section.

## PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS

The lower Churchill River area was divided into 10 reaches as shown on Figure 9-6. The physical changes to the shores are described by reach.

Partridge Breast Lake (Reach 1) - This reach extends from Missi Falls downstream to the inlet of Northern Indian Lake and includes Partridge Breast Lake. The shoreline is predominantly a low, sloping boulder beach with some sections of low alluvial and bedrock or bedrock-controlled shoreline. The water-washed rock zone along the shoreline is 100 to 350 ft in width and sparsely colonized by sedges and grasses.

Significant amounts of low bedrock-controlled shoreline occur in the lower portion of the reach. Intermixed with this shoreline are beaches of coarse-grained materials, and clay shorelines at the mouths of tributaries.

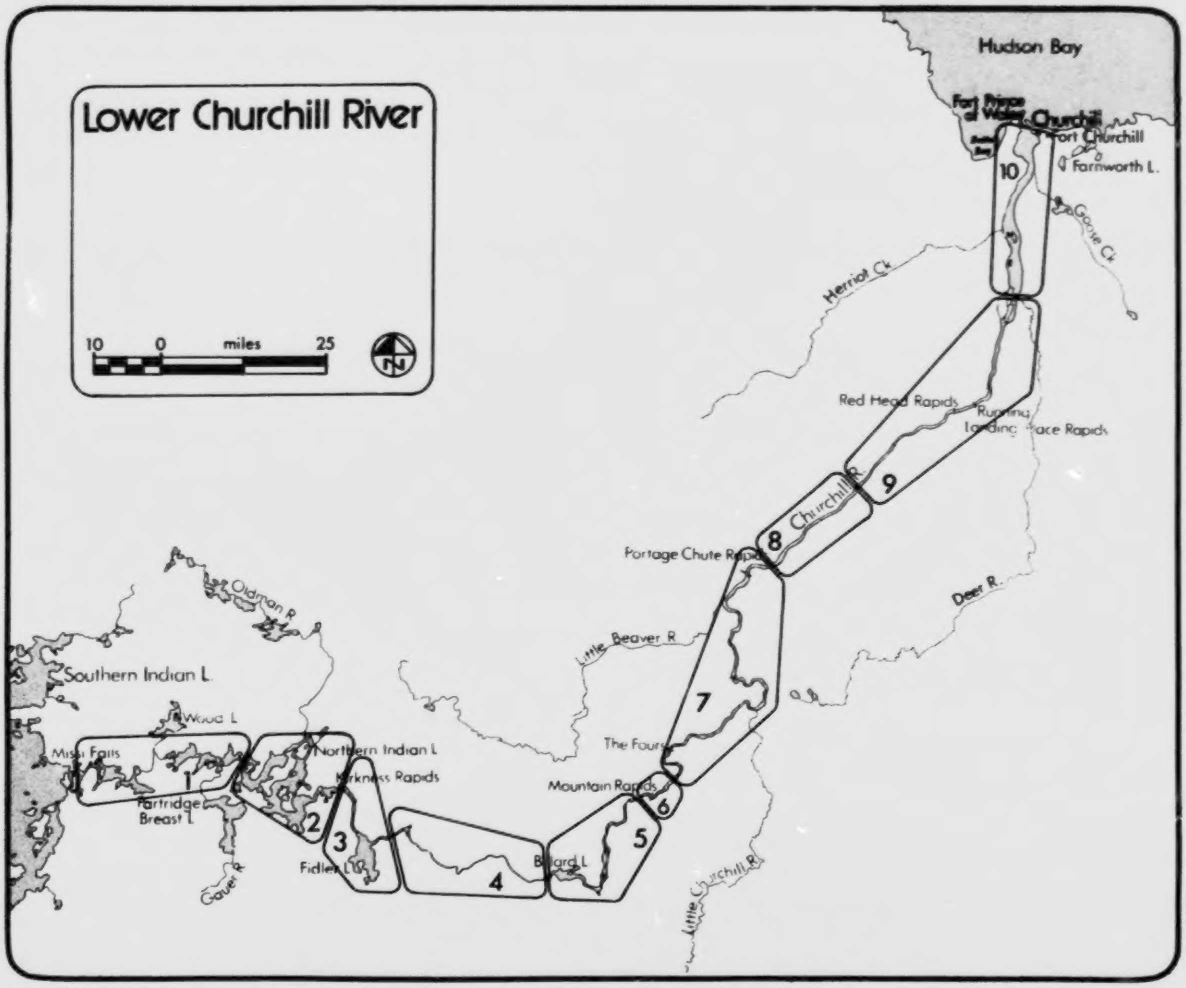

Lower Churchill River
10
0
miles
25
Hudson Bay
Fort Churchill
Farnworth L.
Goose Ck
Herriot Ck
Red Head Rapids
Running
Landing Place Rapids
Churchill R.
Portage Chute Rapids
Deer R.
Oldman R.
Little Beaver R.
Southern Indian L.
Wood L.
Missi Falls
Partridge Breast L.
Northern Indian L.
Kirkness Rapids
Fidler L.
Billard L.
The Fours
Mountain Rapids
Gauer R.
Little Churchill R.
1
2
3
4
5
6
7
8
9
10

Fig. 9-6. Lower Churchill River Reaches.

The channel sections are basically steep, bedrock-controlled shorelines and ice-scoured till banks. The shrub zone is about 6 ft above the mean water level and the extent of grass cover varies with the substrate. Offshore zones are devoid of all hydrophytes.

With diversion of Churchill River flows, there will be a drop in water level at Partridge Breast Lake of almost 10 ft. In the lake areas with low boulder or bedrock shoreline, rock and boulders will be exposed for an average width of 200 to 300 ft. The likelihood of a plant cover establishing itself on the newly exposed rock beach is low due to the lack of soil. The beach areas of bedrock-controlled shorelines will be more conducive to the establishment of new plant cover.

Plant colonization will be best in areas of clay, low alluvial, coarse sediment and fen shorelines. Where there is exposed bedrock no colonization will take place. The width of the ice-scoured zone will be reduced and shrubs will colonize the upper portion of the existing ice-scoured zone.

Northern Indian Lake (Reach 2) - This reach includes Northern Indian Lake and the river channel to the Kirkness Rapids area. Throughout the lake low bedrock and low bedrock-controlled shorelines alternate.

The river channel sections of the reach have proportionately larger amounts of clay, fen and low alluvial shoreline than the lakeshore. The lower river channel also has 5 miles of low shoreline in coarse sediments.

After diversion the mean drop in water level at Northern Indian Lake will be approximately 10 ft. More rock beach will be exposed here than in Reach 1. The horizontal extent of the exposed beach will vary from 50 to 7000 ft. The majority of the bedrock-controlled shoreline will expose a rock or boulder beach varying in width from 100 to 400 ft.

After diversion, the flow will be confined to the deepest portions of the channel, and the width of the river will be reduced by more than one-half along most of the reach. Plant colonization will be the same as in Reach 1.

Fidler Lake (Reach 3) - Included in this reach is the river channel from Kirkness Rapids to Fidler Lake and Fidler Lake. The river channel in this reach is distinguished by a high occurrence of sand and gravel shoreline (11 miles). The banks are higher along the channel than along the lake.

The shores of Fidler Lake have low relief and do not exhibit the steep banks typical of the lakes in the previously described reaches. In general, shorelines are low and bedrock-controlled with glacial till overburden. Most of the beaches are in coarse sediments. Southern sections of the lake have short stretches of low alluvial and fen shoreline. The wave-wash zone (200 to 300 ft wide) is colonized by willows and grasses.

After diversion, the mean water level of Fidler Lake will be more than 8 ft lower. The effect of the water level change will be greater on Fidler Lake than on any other lake along the lower Churchill River because of the shallow depth of this lake. Sections of lake bottom, up to 2000 ft wide, will be exposed along the shoreline in the central part of Fidler Lake. The southern portions of the lake will be cut off from the main body of the lake. These cut off areas will likely remain as small lake-like areas fed by local runoff. There appears to be little sediment on the existing lake bottom, therefore most of the exposed zones will not be colonized by vegetation to any great extent. The shorelines having alluvial material and fens will be colonized by plants.

Fidler Falls (Reach 4) - This reach comprises the Churchill River channel from Fidler Lake to Billard Lake. The river in this reach is typified by rapids and falls separated by low velocity pools. The riverbanks increase in height from Fidler Lake to Billard Lake. The shoreline along the channel is predominantly bedrock, separated by bedrock-controlled stretches. Minor amounts of bank slumping are found throughout the reach, and the water-washed zone is narrow. The overburden is permafrosted till and the backshore vegetation is mainly black spruce with some tamarack and white spruce. The trees are generally less than 30 ft high with some higher ones located on the south-facing slopes.

After diversion, little shoreline change is anticipated in the narrow rapid sections. Wide beaches will develop along the wider, slower flowing sections of the reach.

Billard Lake (Reach 5) - This reach includes Billard Lake and the section of the Churchill River extending 16 miles downstream from the lake, approximately to Billard Rapids. The banks are low and the shorelines have been classified as coarse-grained material, low alluvial or low willow shoreline. Large islands are located in midstream.

Coarse-grained beaches are common. They are generally between 20 and 30 ft wide and have a growth of deciduous shrubs. Either open or closed black spruce forest is found on the backshore with an understory of alder and currant bushes.

The low alluvial shoreline is extensively covered with alder and willow extending some distance backshore as well as into the water. Also, there are 6 miles of marsh shoreline and 6 miles of clay shoreline around Billard Lake. At the downstream end of the lake, there are a few stretches where bedrock outcrops occur. The riverbanks for the first few miles below Billard Lake are slumping.

The new level of Billard Lake will be approximately 9 ft lower after the diversion project is in effect, and the water level in the river channel on the average will be about 8 ft lower. The steeper banks in this reach will remain relatively unchanged. Wide beaches will form in the wide channel sections. Billard Lake will be subdivided by emergent reefs and the one island in the lake will increase in size. The aquatic plants presently growing in offshore areas are not expected to reestablish. The exposed clay and alluvial zones will produce a vegetative cover fairly quickly. The newly exposed shores will vary in width from 100 to 1300 ft.

Billard Rapids (Reach 6) - This reach consists of a 12-mile section of the Churchill River including Billard Rapids and Mountain Rapids. The river channel in this reach is very similar to the channel in Reach 4. Rapids are frequent and the channel section is slightly irregular. The majority of the shoreline has been classified as low bedrock and bedrock-controlled.

As in Reach 4, the shoreline along the narrow channel sections will not undergo much change as a result of the diversion project. Wide beaches will develop where the channel section is wide and where bedrock is exposed it will remain barren.

Upper Canyon (Reach 7) - This reach of the Churchill River extends from the downstream end of Reach 6 to the head of Portage Chute Rapids. The river banks begin to steepen considerably a few miles downstream from Reach 6. Below the mouth of the Little Churchill River, the valley walls start to flatten again and the total rise to the uplands decreases. The overburden in this reach consists of glacial till containing silt, sand and coarse material. The forest cover is predominantly spruce.

Ice-scoured glacial till banks and slumping overburden are dominant features along the shoreline. Slumping is particularly common upstream of the confluence with the Little Churchill River where banks are steep and permafrost is prevalent.

After diversion, a steppe will be exposed which will be colonized by plants. The successional process, with larger types of vegetation moving down the bank slopes, will depend on the height to which the ice scour on these steppes will continue. The newly exposed water-washed zone will support only sparse vegetation because of the presence of coarse gravel and boulders.

Numerous rock ridges will be exposed along the channel bottom in this reach. It is expected that a beach about 160 ft wide will be exposed along the ice-scoured till shorelines. The river will be confined to the deepest portions of the bedrock channel.

Lower Canyon (Reach 8) - This reach extends from approximately Portage Chute Rapids to Bad Cache Rapids. Its main characteristic is a vertical limestone cliff shoreline, about 22 miles long, backed by a smooth rise to the uplands. Ice accumulation does not exceed the height of the limestone cliffs on the upper segment, while downstream the limestone dips below the upper limit of the zone of ice accumulation. There are about 8 miles of ice-scoured till bank separating stretches of bedrock. Slumping is minor. The bank slope here (the lower Canyon) is less than that found in the Upper Canyon. The uplands, however, are nearly 400 ft above the river and nearly a mile is required to reach that height.

Under the reduced post-diversion water levels the width of exposed boulder and rock beach opposite the vertical limestone cliffs is likely to be small. Wider beaches, 100 to 200 ft in width, may be expected opposite the ice-scoured till banks.

Long Island (Reach 9) - The Long Island Reach extends from approximately Bad Cache Rapids to Long Island. As in Reach 7 (the Upper Canyon), ice-scoured glacial till banks are the predominant shoreline type (82 miles). The backshore in these areas is composed of marine deposits with stunted vegetation along the shoreline. Patterned ground, reflecting the effects of permafrost, is extensive in the uplands.

A slumping overburden shoreline is the second most frequent type (17 miles). In these areas, the uplands become tundra-like, especially near Hudson Bay. A thick layer of peat is also common and permafrost is continuous through the reach.

A large portion of the limestone riverbed will be exposed following implementation of the Churchill River diversion project. In this reach. flow will be confined to the lowest part of the channel. Newly exposed beaches will vary in width from 10 to 400 ft. Plant colonization on the exposed bouldery beaches is expected to be slow and sparse.

Long Island to Hudson Bay (Reach 10) - This final reach of the lower Churchill River lies between Long Island and Hudson Bay. The banks are low, similar to those found in the reach below Billard Lake. The banks are composed mainly of granular material and the slopes are mild. The low alluvial is the most common type of shoreline (28 miles). In the last few miles of this reach, Precambrian sandstone protrudes from the marine deposits along the channel. The tree cover in the backshore consists of dwarfed spruce on a heavy moss base. Backshore drainage is poor.

There are 6 miles of exposed bedrock and 5 miles of low, willow shoreline in this reach. Vegetation is sparse with only a few willows and an occasional black spruce. Sedges dot the shoreline.

The lowest portion of the reach contains 22 miles of rooted fen shoreline.

The upstream sections of this reach will have wide areas exposed along the shoreline and in the river channel which will support vegetation soon after diversion is implemented.

In the lower sections of this reach, the impact of the diversion on the shoreline will be less due to the lesser change in water level. The flow in the Churchill River will be restricted to the deeper, central portion of the riverbed except near the mouth where the flow will remain spread over the entire channel width. In this area near the estuary, the water level should remain nearly constant, but salt water will intrude farther up the channel and change the composition of the flora and fauna. The impact on the fen type shoreline will depend upon the tolerance of the species to increased water salinity.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION

## LIMNOLOGY AND FISHERIES

LIMNOLOGY - The Churchill River within 50 miles downstream of Missi Falls broadens into three sizable lakes, Partridge Breast, Northern Indian, and Fidler, before following a well defined river channel into Hudson Bay. The three lakes have a combined surface area of 80 square miles with mean depths ranging from 9.8 to 20.7 ft. Local drainage is a very small component of the hydrologic budget of these lakes. The high Churchill River flows combined with the small volume of the lakes impose short exchange times on the water in the lakes, 1.3 days for Fidler Lake to 9.0 days for Northern Indian Lake.

The limnology of these lakes is broadly similar to that of Southern Indian Lake which is to be expected from the overwhelming role the Churchill River plays in their hydrology. The chemical composition of the lakes is nearly identical with that of the Southern Indian Lake discharge. As Southern Indian Lake presently retains only 10 percent of the phosphorus supplied to it, the lower Churchill lakes have very high nutrient loading rates, but the short residence times are not sufficient to permit effective utilization of the nutrients. Seasonal water quality changes in chemical composition and phytoplankton largely reflect upstream events in Southern Indian Lake. Consequential to the rapid turnover and stronger currents through the lower Churchill River lakes the transparency of the water declines below Missi Falls; this decline in transparency accounts for somewhat lower algal productivity in these lakes as compared with Southern Indian Lake. Contrary to limnological observations in Southern Indian Lake in 1972, there was evidence of oxygen depletion in lower Churchill River lakes during the winter of 1973 with oxygen concentrations after ice-out ranging from 31 to 77 percent of saturation. The winter depletion in dissolved oxygen is partially due to thermal stratification under the ice retarding mixing. During the summer the lakes are isothermal and saturated with oxygen.

Phytoplankton standing crops and productivity in the main stem portions of the lower Churchill River lakes were comparable with, but generally lower than those in Southern Indian Lake near Missi Falls. Average summer biomass declined from Missi Falls through Fidler Lake, and this could be correlated with increasing turbidity downstream attributable to stronger currents.

The effect of the Churchill River water was especially apparent in late September, 1973, when main stem stations exhibited two to three times the algal biomass and productivity of stations off the Churchill River plume. Diatoms predominated at all main stem Churchill River stations while other algal groups were most abundant in bays and Wood Lake, a nearby shield lake off the Churchill River. The clear differentiation of algal populations at that time indicates restricted horizontal mixing of Churchill River water with bays and backwaters off the main stem. Even so in Fidler Lake algal standing crops generally exceeded those of Wood Lake. Therefore, water exchange times calculated on the basis of lake morphometry and discharge rates will underestimate the rapidity with which the Churchill River plume traverses the lakes. A similar phenomenon was noted [illegible] Southern Indian Lake.

The numbers of planktonic crusta[illegible]ease rapidly in the lower Churchill River as compared with the abundances in Southern Indian Lake, Wood Lake and lakes on the Rat-Burntwood system. Also the number of species decreases; however, the dominant species are the same, indicating that Southern Indian Lake is the main origin of the plankton in the lower Churchill River lakes. This is rather typical for a riverine situation where the high flushing rate does not, even in very rich rivers, create favourable conditions for crustacean plankton development. The local plankton numbers are well compensated by the high abundance of benthic fauna.

Standing crops of benthic organisms are comparable with those of Southern Indian Lake with the average number of organisms per unit area being somewhat higher than in Southern Indian Lake. The density of benthic organisms in a nearby shield lake, Wood Lake, was only 9 to 40 percent as high as densities in the three lower Churchill River lakes. The freshwater amphipod, *Pontoporeia affinis*, an excellent whitefish food, was a major component of the standing crops in all these lakes.

EFFECT ON LIMNOLOGY - Lower post-diversion Churchill River flows will increase exchange times somewhat in the lower Churchill River lakes. After diversion under average flow conditions, exchange times for the different lakes will range from 1.3 to 16.4 days compared to 1.3 to 9.0 days as at present. The lakes will still be riverine in nature and the major chemical constituents will reflect discharge at Missi Falls.

Reduced flows could change mixing patterns in the lakes. A deep trough in

Northern Indian Lake will be more likely to thermally stratify in summer than previously, but this trough is less than 15 percent of the total post-diversion lake area and consequently most of the water in this lake will remain isothermal and oxygen saturated through the summer. In winter, however, the present pattern of thermal stratification will intensify under the greatly reduced flows. At present the oxygen depletion that occurs during the winter months results in oxygen concentrations after ice-out that are only 31 to 77 percent of saturation. After diversion these winter oxygen values may decline further.

It has been predicted that there will be appreciable changes in the hydrography of Southern Indian Lake north of Long Point. Increases in total dissolved solids, dissolved inorganic carbon, calcium and magnesium are expected and the lower Churchill River lakes will reflect these changes. It is also expected that nutrient retention above Missi Falls will increase as most of the Churchill River flow is diverted out of South Bay and the greatly increased exchange time for the northern portion of Southern Indian Lake allows more efficient utilization of nutrients. Therefore, concentrations of phosphorus, in particular, will decline in the lower Churchill River lakes. Annual loading rates per unit area will also decline, but the short exchange times for these lakes under average post-diversion conditions makes the meaning of this reduced loading unclear. At present, the composition and standing crops of phytoplankton in the main stem reflect the seasonality of the phytoplankton in Southern Indian Lake, with a general decline in standing crops from Missi Falls to Fidler Lake, reflecting the increased turbidity and turbulence. In other words, much of the algal crop is imported. The short exchange times even after diversion will still maintain this pattern. A general decline to two-thirds the present level has been predicted for algal production in Southern Indian Lake and this decline will probably be evident in the lower Churchill River lakes.

It was mentioned before that the flushing rate after diversion remains essentially unchanged as the large reduction in lake volumes will largely offset the effect of the lower flows. No substantial changes are expected in the present, very low, zooplanktonic abundance as expressed per unit of volume. However, due to lake volume reduction the total quantity of plankton per lake will decrease proportionally to the volume decrease.

On a per-unit-area basis the standing crops of zoobenthos in the downstream Churchill River lakes can be expected to stabilize at approximately two-thirds of present levels. The increased water drawdown and the reduced lake size will, however, substantially reduce the area available for colonization by zoobenthos.

FISHERIES - Northern Indian Lake and Fidler Lake presently support active summer fisheries and during recent years the allowable quota has been frequently exceeded without apparent detriment to the fish stocks. The present quota on all three lakes is 135,000 pounds which would be valued at $23,000 based on 1972 prices. The yield per acre, 0.58 to 1.6 pounds, is 20 to 50 percent of that on Southern Indian Lake (2.5 pounds per acre), but this differential probably reflects a lower intensity of effort as catch per unit effort in experimental gill-nets was generally similar to, or somewhat better than, that in Southern Indian Lake. The catch per unit effort in the experimental nets for the prime commercial species, lake whitefish (*Coregonus clupeaformis*), was 50 to 100 percent higher in lower Churchill River lakes than in nearby Wood Lake. The commercial harvest is almost exclusively whitefish although the experimental nets returned nearly equal weights of northern pike (*Esox lucius*). However, experimental nets were not set with the intention of selective fishing as are the commercial sets. Walleye (*Stizostedion vitreum*) was not prominent in experimental nettings although the walleye catch per unit effort in Northern Indian Lake was comparable to the average in Southern Indian Lake. Growth rates for whitefish were somewhat lower than on Southern Indian Lake, but condition was equally good. The data generated by the study indicate that the lakes are presently under-exploited and that they have a potential for significantly higher yields; only effort is at present limiting the commercial yield.

In summary, the present lower Churchill River lakes appear to be as productive per unit area as those portions of Southern Indian Lake receiving Churchill River flow. In both lake systems the positive effect of river flow on biological productivity including fish is easily demonstrable. These riverine lakes are significantly more productive than nearby shield lakes receiving only local drainage.

EFFECT ON FISHERY - Fish populations will eventually respond to the general reduction in the productivity of the lower trophic levels. With the probable qualitative and quantitative changes in benthos a reduction in the whitefish population will almost certainly occur. The decrease in food supply will be aggravated by a lower spawning success. New spawning sites will have to be established; rock areas will be unsuitable until wave action resuspends and removes the existing sediment layers. Under average conditions, falling water levels will be occurring during and just after whitefish and cisco spawn. Under natural conditions there is less than 5 percent chance of a 2 to 4 ft drop in September and October during the whitefish spawning season on Northern Indian Lake. After diversion, the corresponding probabilities are 58 percent in September and 20 percent in October and there is a 13 percent chance that water levels will drop 4 to 6 ft. Water level changes on Fidler Lake and Partridge Breast Lake during this time will be even more severe. The magnitude and timing of these declines present hazards for deposited spawn. Walleye spawning during the spring in streams should be less severely affected, but deposited spawn may be flooded to greater depths due to the greater annual fluctuations in water level and may be covered with sediment. The larger areas of unstable shorelines and mud flats after diversion will likely reduce pike (*Esox lucius*) spawning success as well.

The commercial fishery potential will be affected by reduced fish populations. Catch per unit effort will decline and fishing effort on the lakes could cease entirely because of this. Lower lake levels would also entail the construction of new fish camp facilities to allow reasonable access to the new shoreline. Without new facilities the effort to fish would decline further but construction of new facilities would not guarantee the maintenance of the fishery when success is declining.

The foregoing assessment of probable impact forecasts lower biological productivity in the lower Churchill River lakes after diversion under average conditions. Under minimum flow conditions allowable by the interim licence the impact will be more severe with a general aggravation of the phenomena discussed above. With the accompanying loss of aquatic habitat due to lower water levels and reduced area, it is clear that there will be a drastic reduction in the potential fish production in the lower Churchill River lakes. Fish production of the lower Churchill River is also threatened. A recently completed ice study indicates that under minimum allowable flows (present interim licence) the lower Churchill River, downstream of the lakes, may freeze solid obliterating most aquatic life.

## WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE

Use by wildlife of lakeshores and riverbanks along the lower Churchill River is dependent on shape and character of the substrate, vegetation, and habitat requirements of individual wildlife species. Average annual flows at Missi Falls will be reduced to 25 percent of normal, with significant reductions in lake surface areas. Changes in the shape of shorelines and vegetation along these shorelines will occur. These changes in the physical environment will affect wildlife populations in the area. Photographs of typical wildlife habitat are shown in Fig. 9-7 to Fig. 9-12.

## WILDLIFE HABITAT AND POPULATIONS

Ungulates - Moose (*Alces alces*) in this area face severe climatic conditions; populations are consequently small. Suitable habitat is limited to the immediate shores of the Churchill River and its lakes where a narrow band of browse species is available. Much of the river shoreline between Missi Falls and Fidler Lake is predominantly rocky and provides little suitable browse. Islands in Northern Indian Lake are used by moose during the calving season, probably isolating them from predators. Shorelines downstream from Fidler Lake are often ice-scoured and may provide only a narrow band of shrubs. Forest cover becomes increasingly sparse downstream from Fidler Lake and there are long stretches of unsuitable steep shoreline. Numerous small ponds, creeks and bogs upstream from Fidler Lake have limited amounts of browse associated with them. Some suitable habitat occurs in marshy bays around lakes. Several recent forest fires in the area have produced little deciduous browse.

Potential carrying capacity of the area between Missi Falls and Billard Lake is probably 0.2 to 0.3 moose per square mile while carrying capacity downstream of Billard Lake is less than 0.2 moose per square mile.

Barren-ground caribou (*Rangifer tarandus*) occurring in the lower Churchill River area belong to the Kaminuriak population. This population undertakes long migrations from calving and rutting grounds in the Northwest Territories, sometimes south to the Churchill River, then west above Southern Indian Lake to wintering grounds northeast of Reindeer Lake. During this migration, caribou may move close to the river, but apparently do not cross it.

Based on availability of forage, the region from Missi Falls to Billard Lake may be the best caribou winter range. Infrequent large sedge meadows such as that east of Kirkness Rapids may offer feeding opportunity to migrating caribou.

Furbearers- Furbearers include beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), lynx (*Lynx canadensis*) and mink (*Mustela vison*). Suitable habitat is limited. Aquatic habitat necessary for beaver and muskrat is limited to marshy shorelines and tributaries of the river system. Lynx are restricted to the narrow band of forest cover where prey species can be found.

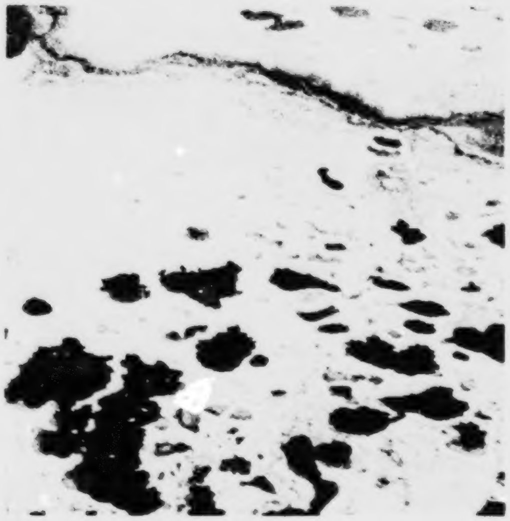


Fig. 9-7. Muskeg potholes, Hudson Bay Lowlands. Canada geese nest in this type of habitat at approximately 5 pairs per square mile.

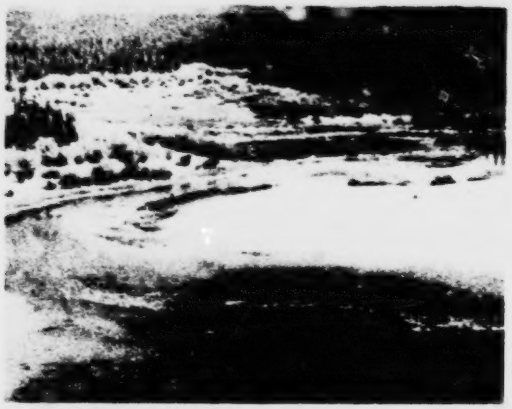


Fig. 9-8 Small stream with marsh fringe leading into Fidler Lake, lower Churchill River. Waterfowl use these small marsh areas for breeding and staging.

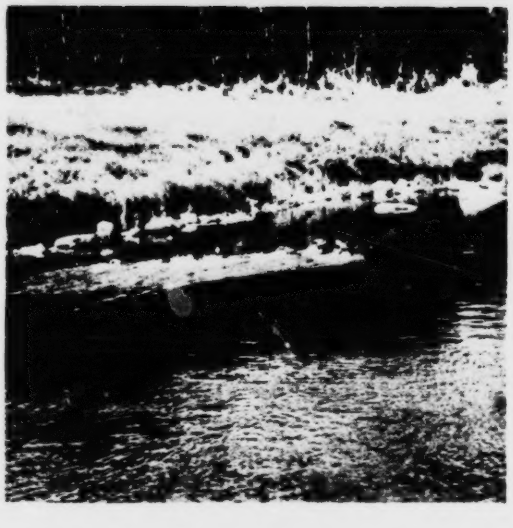


Fig. 9-9. Pair of Canada geese with brood along ice-scoured shorelines, lower Churchill River. Geese nesting along the river and in adjacent muskeg ponds bring their broods to the abundant grasses and sedges of these shorelines.

Fig. 9-10. Grasses and sedges along ice-scoured shoreline east of Billard Lake, lower Churchill River. This area has been used heavily by feeding Canada geese.

Fig. 9-11. Steep ice-scoured shoreline, lower Churchill River, August 1973. Some goose activity was noted along these shorelines, but less than on more gently sloping shorelines.

Fig. 9-12. Limestone cliffs at Portage Chute Rapids, lower Churchill River. Approximately 20 percent of the shoreline from Portage Chute Rapids to Red Head Rapids is of this type. Value to most species of wildlife is low due to steep slope and lack of vegetation.

Polar Bears - Polar Bears (*Ursus maritimus*) inhabit the coastline of Hudson Bay, including the area around the mouth of the Churchill River. Inland movement rarely takes them up to 100 miles from the coast.

Each fall about 250 of this endangered species congregate in the Cape Churchill region in preparation for departure onto winter sea ice to hunt seals. It is during this period that problems result from the bears' proximity to civilization. By mid November, the ice has usually formed and most of these bears move out into Hudson Bay.

Waterfowl - This area is moderately productive of waterfowl when compared to the rich agricultural areas of southern Manitoba. Severe climate and lack of sufficient breeding habitat are major factors limiting production.

Significant numbers of Canada geese (*Branta canadensis*) are attracted to the area by its remoteness, by muskeg ponds and by vegetation growing along ice-scoured riverbanks.

Nesting by most species of waterfowl is confined to the infrequent marsh habitat generally associated with lakes. Canada geese nest on islands in the major lakes and in upland ponds and lakes adjacent to the river. Although the actual riverbanks are apparently not important to nesting geese, they are used as feeding areas during the brooding season. Densities of Canada geese in the vicinity of the river may vary from 0.2 to 5.8 pairs per square mile during the breeding season.

Dabbling ducks such as mallards (*Anas platyrhynchos*), American widgeon (*Mareca americana*) and diving ducks such as lesser scaup (*Aythya affinis*) utilize marsh areas for breeding. Major use of the lakes along the river is by staging flocks of diving ducks. Mergansers (*Mergus* spp.) and common goldeneye (*Bucephala clangula*) are most prevalent among these flocks. Whistling swans (*Olor columbianus*) and snow geese (*Chen caerulescens*) also use the river and its lakes in limited numbers on migratory stops.

Cowan (1975),[9-2] in an independent assessment of waterfowl use of the river, concluded that the waterfowl production per shoreline mile was low along the lower Churchill River compared to more southerly areas. Although productivity is low per shoreline mile, Cowan points out that the total number of geese produced along the lower Churchill River is substantial due to the large number of shoreline miles.

EFFECT ON WILDLIFE HABITAT AND POPULATIONS - Diversion of flows from the Churchill River will greatly decrease river flows and lake levels. Periods of peak flow in spring will occur earlier than normal. Large areas along lake shorelines will be exposed allowing colonization by terrestrial vegetation. The effect of the diversion will depend on the individual animal species' ability to adjust to the new regime.

Effect on Ungulates - The overall potential of the area to produce moose should not be detrimentally affected by the diversion. New willow shrub communities that develop along exposed shorelines will offer additional browsing opportunity for moose. Current marsh areas will largely disappear, reducing the amount of aquatic vegetation which is not high under natural flow conditions. Some of the calving islands may become accessible from shore, allowing increased predation.

Caribou will not be affected by the diversion if they maintain current migration patterns.

Effect on Furbearers - Changes in vegetation along the river will directly affect furbearer habitat and populations. Loss of current marsh areas will reduce muskrat habitat. New deciduous shoreline habitat may support a slightly increased population of predatory furbearers such as lynx. Potential for production of beaver may also be reduced.

Effect on Polar Bears - Reduced fall flows in the Churchill River may have an effect on polar bears at Cape Churchill. Delay of formation of land fast accretion ice along the coast could result in bears remaining on land longer than under normal circumstances. Problems currently existing each year in the town would then continue for a longer period. Changes in the vegetation of the estuary, caused by the different flow and nutrient regime, could affect vegetation and food resources available to bears.

Effect on Waterfowl - With lowered water levels most of the marsh habitat currently used by nesting waterfowl will be overgrown by perennial shrubs. Ice scouring will be reduced or eliminated, significantly decreasing the value of the river to Canada geese.

Waterfowl along the river will be greatly affected by proposed maximum releases in May and June during the peak nesting period. Water levels will rise

6 to 7 ft during this time.

Staging waterfowl will also find fewer marsh areas in which to feed and their food supplies will decline. This will make the area unattractive to many of the birds and reduce their use of the lower Churchill River.

Cowan (1975) concludes that, after diversion, reduction in production of young could be critical to the Canada geese of the Western Prairie Population. Members of this group probably are the most abundant breeders in the lower Churchill River lakes area, although members of the Eastern Prairie Population may also be present. The Western Prairie Population is much smaller than the Eastern Prairie Population and any loss of production would be of proportionately greater consequence. The proportion of Western Prairie Population geese involved is not known; hence the losses in production they may sustain cannot be determined.

WILDLIFE USE - Hunting and trapping are not extensive activities along the lower Churchill River.

Hunting - Trappers and fishermen in the lower Churchill River lakes area likely shoot a few moose. Sport hunting for moose is negligible due to low densities and difficulty of access.

Utilization of caribou by natives in the north has been opportunistic, fluctuating annually and linked to winter distribution of caribou. In the early 1950's animals were killed throughout northern Manitoba by Indians from Split Lake, Nelson House, Churchill and South Indian Lake. With reduced population size and limited southward penetration, the caribou kill has been much less in recent years. Trappers along the Churchill River could take some caribou as the migration occurs near areas actively trapped but the number shot is undoubtedly small.

In Manitoba, hunting of polar bears is restricted and numbers shot annually are not high. Sport hunting is not allowed. Some "problem" bears have been killed near Churchill when other efforts to disperse them failed. Five bears were killed in the fall of 1973.

Due to limited access and low concentrations, few Canada geese are killed by sportsmen along the lower Churchill River. Presumably geese, breeding in the area from Missi Falls to the Hudson Bay lowlands, remain to stage in this generally inaccessible region. Tundra geese from the lowlands move to the coast and are subjected to light to moderate hunting pressure. Geese breeding in the area are a large variety, highly prized by hunters and viewers of wildlife. Use of waterfowl by natives along the lower Churchill River is not known but is likely minor and opportunistic. Geese are probably taken in small numbers.

Geese from the Western Prairie Population that nest west of Mountain Rapids on the lower Churchill River fly over southern Manitoba enroute to wintering grounds mainly in South Dakota.

Trapping - Low returns from most of the registered traplines along the river are largely attributable to travel difficulties, long distances and low furbearer densities.

Registered traplines along the lower Churchill River are organized into Southern Indian Lake, Split Lake and Churchill sections. The average annual fur harvest value from 1967-68 to 1971-72 from traplines which may be affected by the diversion was $9,340. Returns from the Churchill section accounted for only 9 percent of this total (Table 9-5).

TABLE 9-5
FUR HARVEST VALUES OF AFFECTED REGISTERED TRAPLINES ALONG
THE LOWER CHURCHILL RIVER, 1967-68 to 1971-72

| Year | Churchill Section | Split Lake Section | Southern Indian Lake Section | Total |
|---|---|---|---|---|
| 1967-68 | $1,016 | $3,536 | $5,778 | $10,330 |
| 1968-69 | 1,131 | 9,839 | 5,350 | 16,320 |
| 1969-70 | 1,023 | 5,974 | 2,144 | 9,141 |
| 1970-71 | 319 | 1,648 | 1,795 | 3,762 |
| 1971-72 | 592 | 3,615 | 2,943 | 7,150 |
| AVERAGE | $ 816 | $4,922 | $3,602 | $9,340 |

Affected traplines in the Split Lake section have a fair production of beaver and mink, low muskrat production and very low numbers of lynx. Traplines affected within the Southern Indian Lake section produced moderate numbers of beaver, few lynx and muskrat, and fair numbers of mink.

EFFECT ON WILDLIFE USE - Unless current utilization patterns change, effect of the diversion on use of wildlife in the area will be generally small.

Effect on Hunting - Overall potential of the area to produce moose should not be seriously affected by the diversion project. Moose hunting should not be significantly affected as harvests are presently low and access is difficult.

Impact on caribou after diversion is not expected to be significant since their migration zone extends considerably north of the Churchill River. There will be no effect on utilization of caribou by natives.

Effect on Trapping - Changes in vegetation along shorelines resulting from reduced flows and levels along the lower Churchill River and lakes will directly affect furbearer habitat and consequently production potential.

The effect on trapping methods may be more significant than changes in habitat. Transportation to traplines will become more difficult with changes in the water regime.

A reduction in marsh areas will reduce the potential of the area for muskrat production, but as this is presently low, the effect on trapper income should not be serious. Average annual values of affected registered traplines (RTL) are given in Table 9-6. The area of Northern Indian Lake (Southern Indian Lake RTL's 12 and 13) and the Churchill River from Fidler Lake to downstream of Billard Lake (Split Lake RTL's 38,39 and 46) show the highest returns. As there is no information available showing where furbearers are trapped in these registered traplines an accurate assessment of potential effects cannot be made.

Traplines in the Churchill section show very low returns. Much of the production in this area may come from small creeks and ponds off the main system. Trapper motivation may be low in the community of Churchill as other work alternatives are more attractive than trapping.

## OUTDOOR RECREATION

This section contains an assessment of the effect of water regime changes in the form of severely reduced flows in the lower Churchill River on the recreation potential of the river from Missi Falls to Fidler Lake and in the vicinity of the community of Churchill.

PRESENT RECREATION USE - Use of the lower Churchill River for recreation is limited at present to the 60 miles upstream from Churchill. There are three cottage

TABLE 9-6
AVERAGE ANNUAL RETURNS FROM REGISTERED TRAPLINES
AFFECTED ALONG THE LOWER CHURCHILL RIVER, 1967-68 to 1971-72

| Churchill Section | | Split Lake Section | | Southern Indian Lake Section | |
|---|---|---|---|---|---|
| Registered Trapline No. | Average Value | Registered Trapline No. | Average Value | Registered Trapline No. | Average Value |
| 2 | $ 290 (3) | 38 | $ 1,376 | 10 | $ 205 (3) |
| 11 | 299 | 39 | 1,763 | 11 | 587 (3) |
| 12 | 298 (2) | 46 | 1,005 | 12 | 1,953 (4) |
| 14 | 116 (1) | 50 | - | 13 | 1,277 |
| 15 | - | 51 | - | 14 | 478 (3) |
| 16 | 48 (1) | 52 | 252 (4) | | |
| 17 | - | 53 | 719 (4) | | |
| Community Line | 317 (3) | 55 | - | | |

*NOTE: Number in brackets indicates number of years of data if less than 5.*

areas on or near the river; one is a subdivision near the end of the road running from Churchill to the water intake and pumphouse; the second, Camp Nanuk, is 7 miles east of Fort Churchill; and the third consists of scattered cottages upstream along the Churchill River.

The first area contains thirteen cottages and lots are being surveyed for eighteen more; however, this is not expected to meet local demand. The land is leased yearly from the Manitoba Department of Mines, Resources and Environmental Management. The Churchill River is within walking distance and residents keep their boats at a marina on Goose Creek. Camp Nanuk is located on a lake and is owned by the National Research Council. The third area upstream consists of twenty cottages within 5 to 10 miles of Goose Creek. They are accessible only by boat, and the residents are dependent upon the river for access.

Grayling fishing at Goose Creek is excellent, and pike, speckled trout, and walleye are caught in the Churchill River and its tributaries, especially the Deer River. Winter sport fishing for pike is carried out around the mouth of the Herriot River. The lower Churchill River is used extensively in the fall for goose and duck hunting and some moose are taken. Winter power tobogganing is also popular.

The Churchill River below Missi Falls, due to its inaccessibility and the dangers of the route, attracts only one or two canoe parties per year. Sport fishing is limited to these parties and is not likely to increase in the foreseeable future.

POTENTIAL RECREATION USE - Local tourism in the Churchill area has been limited due to a lack of facilities rather than a low potential. Demand exists for expansion and provision of services to existing cottage areas. The Northland Inn concept of central tourist lodges in major northern population centres with remote outcamps appears feasible for Churchill. Locations for outcamps in the Barren Lands, the polar bear areas and York Factory, appear feasible as part of a "tundra tours" package.

The potential also exists for guiding and outfitting canoe parties using the Deer River, goose hunting organized by the local Co-operative, and development of Fort Prince of Wales and Cape Merry into tourist attractions. These attractions, plus expansion of existing facilities to meet tourist demand, could lead to the development of the Churchill area into a tourist attraction oriented toward a broader base than the Churchill Whalers Co-operative Association Ltd. and the present Canadian National Railways train excursion.

Severely reduced flows, however, could reduce this potential by making present cottage areas unattractive, the river and tributaries too shallow for recreation boating, and seriously reducing sport fishing potential.

The Churchill River below Missi Falls will not receive any more use than it presently does. The airstrip at Missi Falls may draw in a few (two or three) fishing or hunting parties annually but general use would be intermittent.

The lower reach of the river to Churchill is part of the Hudson Bay lowlands and could receive prime consideration for National Park designation. The Parks Canada system does not contain a representative example of the Hudson Bay lowlands. However, if the severe effect of the reduced flows on the sensitive ecosystems is not mitigated, this consideration could be negated in favour of an area that would not be altered.

EFFECT ON EXISTING AND POTENTIAL RECREATION USE - In terms of recreation use, the lower flows could make the river safer for canoeing; however, the grandeur of a wild, untamed, northern river would be reduced. The route in its pre-diversion state was dangerous to travel with over 50 sets of rapids and falls between Missi Falls and Churchill. Portages around these rapids and falls are unmarked or non-existent. The risks are too great for it to become a highly travelled canoe route. The traditional route to Hudson Bay and Churchill is via Moss Lake at the North end of Southern Indian Lake to Little Sand Lake, Chipewyan Lake and the Seal River to Hudson Bay. Inaccessibility of the area and the dangers involved in a trip down the Churchill River will continue to severely limit its use; maximum use may be one or two parties per year.

Although the area is relatively inaccessible and its use is severely limited, the aesthetics of the region would be destroyed. Pristine lakes would undergo significant change as the water levels are lowered and lakes become surrounded by unsightly mud flats; and a spectacular wild river would be modified by the drastic reduction in flow.

The large decrease in flows along the lower Churchill River will expose large expanses of mud flats. These mud flats will also make shore access difficult for humans and animals.

## TRANSPORTATION AND NAVIGATION

This section describes the existing transportation infrastructure of the lower Churchill River area and examines the possible effects of the diversion of flows from the Churchill River on the transportation system. Possible effects of the hydroelectric development on the transportation facilities in the community of Churchill and on the length of the navigation season in the Port of Churchill are also considered.

EFFECT ON EXISTING TRANSPORTATION AND NAVIGATION FACILITIES - At present the lower Churchill River area is not served by any all-weather regional roads. The construction site at the Missi Falls control structure has a network of local roads for internal access. These roads, built by Manitoba Hydro, will not be affected by altered water levels.

Manitoba Hydro has constructed and operates a winter road between South Bay and Missi Falls for movement of traffic to the Missi Falls construction site. There are no other winter roads in the lower Churchill River area. The reduced current at the outlet of Southern Indian Lake, resulting from operation of the Missi Falls control structure, may facilitate formation of ice immediately upstream from Missi Falls and on the lower Churchill River. Consequently it is expected that crossing of the river in winter will be improved following the implementation of the diversion.

The Hudson Bay branch of the Canadian National Railways enters the lower Churchill River area at Chesnaye, 40 miles south of the Churchill townsite. The line, completed in 1929 to provide access to the Port of Churchill primarily for wheat shipped from Saskatchewan and Manitoba, is not located close to the channel of the Churchill River. At its closest point near Tidal, immediately south of the townsite, the line comes within 2 miles of the river. The diversion scheme will not affect the railway embankment.

Other than navigation through the Port, the only navigation in the area is from South Bay to the Missi Falls construction site. Water access to Missi Falls is provided by barge service (two barges with 200-ton capacity) from South Bay. A wharf has been constructed by Manitoba Hydro to serve the construction site as the facility for unloading construction materials. The navigation consequences of the hydroelectric development for water movement on Southern Indian Lake also apply to water access to Missi Falls. The wharf at Missi Falls is not expected to be affected by high water levels on Southern Indian Lake. As a result of the diversion of flows, water levels along the lower 220 miles of the Churchill River will be substantially reduced during the summer months. Since there is no navigation for commercial purposes on this stretch of water at present, no adverse effect is anticipated.

Air transport service to the Missi Falls control structure construction site was provided by float equipped aircraft until the fall of 1973 when a major airstrip was completed by Manitoba Hydro. Since then, the floatplane base has not been operational as wheeled aircraft replaced float equipped aircraft. No effect on the airstrip at Missi Falls is anticipated as a result of altered water levels.

EFFECT ON RESOURCES AND TRANSPORTATION IMPLICATIONS - The forest zone adjacent to the lower Churchill River is primarily transitional from forest to tundra. In view of severe climatic and terrain characteristics, it is not foreseen that forestry will form part of the resource inventory of the area. At present there is no commercial fishery in the area other than on the lower Churchill River lakes which are fished by the Ilford Co-operative Limited with the fish transported by air to Ilford. Mineral resource potential in the area has not been identified. Similarly, there has been no identification of any specific sites as prime recreation areas. The implications of the hydroelectric development to transportation as related to forestry, fishing and potential mining operations are expected to be minimal or non-existent, while the impact of the diversion project on transportation as a means of access to recreation sites is difficult to assess at this time.

EFFECT ON TRANSPORTATION INFRASTRUCTURE AT CHURCHILL - An elaborate network of local roads links the four distinct areas comprising the town: Fort Churchill, Dene Village, Akudlik and the townsite. The roads are aligned far enough from the Churchill River so as not to be affected by reduced flows in the channel.

There is no bridge across the Churchill River connecting the town on one side of the river with Fort Prince of Wales (National Historic Site) on the other side. In winter, crossing is possible by snowmobile across the ice. This short trail is the only winter road in the area. The diversion of flows from the Churchill River is not expected to adversely affect this crossing.

Navigation relates only to the Port facility. There is no navigation from Churchill inland on the river except for recreation boating and boat access to cottages discussed earlier.

There is one seaplane base in the area at Farnworth Lake, south of the airport. It is operated by Lambair Ltd. from July to September. Farnworth Lake is very shallow and numerous submerged rocks make landing hazardous. Since the lake is not connected to the Churchill River, reduction in river flow will not affect lake depths. Similarly, a reduction in water table will not take place since the lake is situated 5 miles from the river channel and drainage is in the direction of Hudson Bay.

The airstrip at Churchill airport consists of two runways (asphalt, 9200 ft and gravel, 6080 ft) at an elevation of 94 ft. The airport is operated by the Canada Ministry of Transport and is fully equipped for instrument landing. It will not be affected by the hydroelectric development because of its distance from the Churchill River channel.

The Hudson Bay Railway is Churchill's only land transportation route to the south. For many years, Churchill residents have made representations for extension of the provincial highway network to provide year-round surface access to Churchill. More specifically, the demand has been for extension of the road system from Thompson to Churchill.

PORT OF CHURCHILL - PRESENT AND FUTURE USE - The Port of Churchill, located in the estuary of the Churchill River on the west side of Hudson Bay, is an integral part of the transportation system of the prairie and eastern arctic regions. It is one of Canada's national harbours and is administered by the National Harbours Board. The chief advantage of the Port of Churchill and the Hudson Bay route to farmers and businessmen on the prairies is the shorter rail haul from seaport to prairie points of origin or destination as compared to the St. Lawrence River ports. Mileage comparisons between Saskatoon and Liverpool, England, via Montreal and Churchill indicate an overall reduction of 1100 miles via Churchill. Another advantage of Churchill over other shipping routes for exports and imports to and from Europe is related to the capacity for traffic growth on the Hudson Bay route.

The Port functions primarily as a shipment point for wheat and barley from Saskatchewan to western Europe. Exports of other commodities have been negligible, while foreign import traffic has also been minute compared to grain exports. Petroleum products have accounted for the bulk of the total inward movement.

A small percentage of the cargo shipped through Churchill is destined for the settlements in the Keewatin District of the eastern arctic. Petroleum products are the principal commodities shipped from Churchill. Other commodities are shipped directly from Montreal. However, the future role of Churchill as an arctic re-supply port will be considerably enhanced with the establishment in 1975 by Northern Transportation Ltd., a federal Crown Corporation, of a marine shipping and forwarding operation at Churchill.

It is difficult to assess the future use of the Port of Churchill. It is generally believed that considering the present facilities, with no extension to the navigation season, the port has a potential for handling 30 million bushels of grain per season. To date maximum grain shipments through the Port have been 25 million bushels. Until the 1974 shipping season, the volume of other exports through Churchill had not shown any increase in the past 10 years; it had remained relatively constant at 5 to 10 percent of total shipments. However, experimental shipments of sulphur from Alberta (stockpiled at the Port during the winter of 1973-74) were made in the 1974 navigation season when 50,000 tons were shipped. It is anticipated that annual shipments will increase to 100,000 tons or more. At the same time the federal government, through the National Harbours Board, has initiated a 6 year, $12,500,000 program for modernization and refurbishing of the Port's wharf and other facilities. Another source of potential traffic through Churchill would be potash from Saskatchewan, which would depend on export market conditions and the availability of storage and handling facilities at Churchill.

EFFECT ON PRESENT AND FUTURE USE OF PORT OF CHURCHILL - In order to assess the possible effects of diversion of flows from the Churchill River on the operation of the Port of Churchill, it is necessary to evaluate the effects of reduced flows on slush ice formation in the mouth of the Churchill River.

The present navigation season at Churchill extends, on the average, for an 82-day period from July 23 to October 15. These dates are subject to ice conditions at the mouth of the Churchill River (the harbour area) and in the Hudson Strait. The latest date for closing the harbour is subject to the effects of cake or slush ice formed inland and carried downstream by the Churchill River. Slush ice is caused by fresh water in the Churchill River freezing in advance of the saline Hudson Bay waters. The slush ice collects in the harbour area hindering movement of vessels in and out of the port.

During 1928-62 actual dates of harbour closing as a result of this condition were:

| | | |
|---|---|---|
| October 9 | - | 0 percent of the years |
| October 15 | - | 19 percent of the years |
| October 22 | - | 53 percent of the years |
| October 29 | - | 82 percent of the years |
| November 9 | - | 100 percent of the years |

Slush ice conditions impair navigation through Hudson Strait in the same manner as at the Port. November 10 is the latest safe date for unescorted, unstrengthened vessels to pass through the Strait. Since Hudson Bay is relatively ice free during this time, an approximate 26-day period exists (October 15 - November 9) between closing of the Port of Churchill due to ice conditions in the harbour area, and initiation of slush ice conditions in Hudson Strait.

Should the slush ice problems in the harbour area be solved, the closing date of the navigation season on the Hudson Bay route would be delayed an average of 26 days. In this connection, the report "Royal Commission Inquiry into Northern Transportation" (Manitoba)[9-3] had noted in 1969 that if an economical method were found to reduce or eliminate slush ice in the harbour, it would be possible to extend the shipping season by about 23 days beyond the present limit of normal insurance (October 15) and about 13 days beyond the average date on which the harbour is forced to close due to ice.

An investigation funded by the Study Board examined the process of ice formation. Under present conditions, with early winter discharges of around 35,000 cfs, the flow velocity is comparatively high and along the complete river length there are only a few areas where bridging of ice could take place. Under present conditions, in the absence of local bridging effects, large quantities of ice flow down the river in early winter. In the estuary, this ice floats on a layer of cold fresh water at 32°F which prevents its being melted by the warmer sea water below. A large amount of ice is also formed by the cold, fresh water flowing over the shallow mud flats in the estuary. Evacuation of the estuary ice depends largely on the strong current during ebb tide. This does not take place until the fraction of the surface covered by the ice is very high; hence crowding of the Port by early ice. As winter progresses, under the effect of shoving due to high local ebb tide velocities, a very thick ice plug forms around the north end of the present dock. Even when the volume of ice is not excessively large, the surface flow pattern in this area creates a concentration of ice along the dock face which hampers berthing. The moving ice, flowing along the dock, jams between the dock face and the ship's bow, ultimately exerting heavy loads on the mooring lines.

The reduction of flow in the river would facilitate early winter local ice bridging just upstream of the Churchill water intake which would also stop practically all floating ice from reaching the estuary. To assist in formation of an early and reliable ice bridge, use of a floating boom just upstream of the water intake could be very effective. The boom would have to be fairly long and consequently would be expensive. Reduction of flow to an optimum value, and construction of small rockfill weirs recommended in relation to the water intake for the Churchill community, would increase the probability of formation of an early, stable ice bridge. The ice bridge would trap the floating ice and none would reach the estuary.

Thus, reduction of the river flows would have beneficial effects on the Port. Ice inflow into the estuary would be considerably reduced and the final freezeup date would be delayed by at least 15 days.

It is not possible at this time to indicate the specific effects which the diversion project will have on sedimentation in the harbour. It would be necessary to identify the source of the sediment deposited by the Churchill River at its mouth; to determine whether a substantial reduction in the existing flow on the lower Churchill River will reduce the rate of erosion along its banks and along the banks of its tributaries; and to determine, on the assumption that the rate of erosion is unchanged, whether the reduced flow on the lower Churchill River will increase the volume of sediment deposited in the harbour area. In the absence of the necessary data, it cannot be concluded whether the diversion of Churchill River flows will cause either an increase or a decrease in the amount of sediment deposited in the harbour area, and whether this would necessitate an accompanying increase or decrease in the cost of dredging operations to maintain a suitable channel depth.

Any attempt to identify the impact of the hydroelectric development on the Port must consider other limiting factors which may be modified as a result of effects on length of season and sedimentation. The two most important of these other limiting factors are high railway freight rates and high marine insurance rates.

In summary, the diversion of Churchill River flows will reduce the volume of slush ice found in the harbour area after October 15 and thereby increase the length of the navigation season at the Port by about 15 days. Diversion of flows may also reduce the volume of sedimentation in the harbour area. Additionally, limited data indicate that the reduction in flow in the Churchill harbour area will reduce ebb tide velocities, thereby facilitating the turning and berthing of ships.

The study of the effect of reduced flows on the ice regime in the harbour concluded that the proposal to construct a 1200-ft breakwater at the south end of the harbour as a measure to control slush ice required further study before its implementation, inasmuch as it appeared to have very limited usefulness and might even create some new problems.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER ON COMMUNITIES IN THE LOWER CHURCHILL RIVER AREA

Churchill is the only community located in the lower Churchill River area which will be affected by the Churchill River diversion project. Although the community of Ilford is located outside the lower Churchill River area, it will be affected by the diversion project.

## CHURCHILL

RECREATION - Cottaging is prevalent in the local Churchill area with hunting, fishing and boating being the predominant related activities. The anticipated changes in the water regime will have a detrimental effect on these activities since they are water-based pursuits.

WATER SUPPLY - The water for the Churchill area is supplied from the Churchill River by a system operated by the Canada Department of Public Works. Treatment of the water is confined to chlorination although the Local Government District has installed facilities to add fluorine to the townsite water supply.

The intake structure is located on the Churchill River just upstream from a series of rapids, known as Goose Rapids, approximately 9 miles from Hudson Bay (Fig. 9-13). A lengthy intake structure conveys the water to a pumphouse on the bank of the river. The water is heated prior to being pumped to a reservoir at a location near the shore of Hudson Bay, midway between the townsite and Fort Churchill.

In the early winter, there is some possibility of slush or frazil ice intrusion into the intake but this has not caused serious problems.

No salt water intrusion into the intake has been observed, but maintenance problems due to external corrosion of the watermain between the intake pumphouse and the main pumphouse have been encountered.

Several problems are foreseen under the reduced flow regime.

During the early winter the intake area would most probably remain free of ice cover because of bridging a little farther upstream. This would provide conditions conducive to the generation of local frazil and anchor ice which could

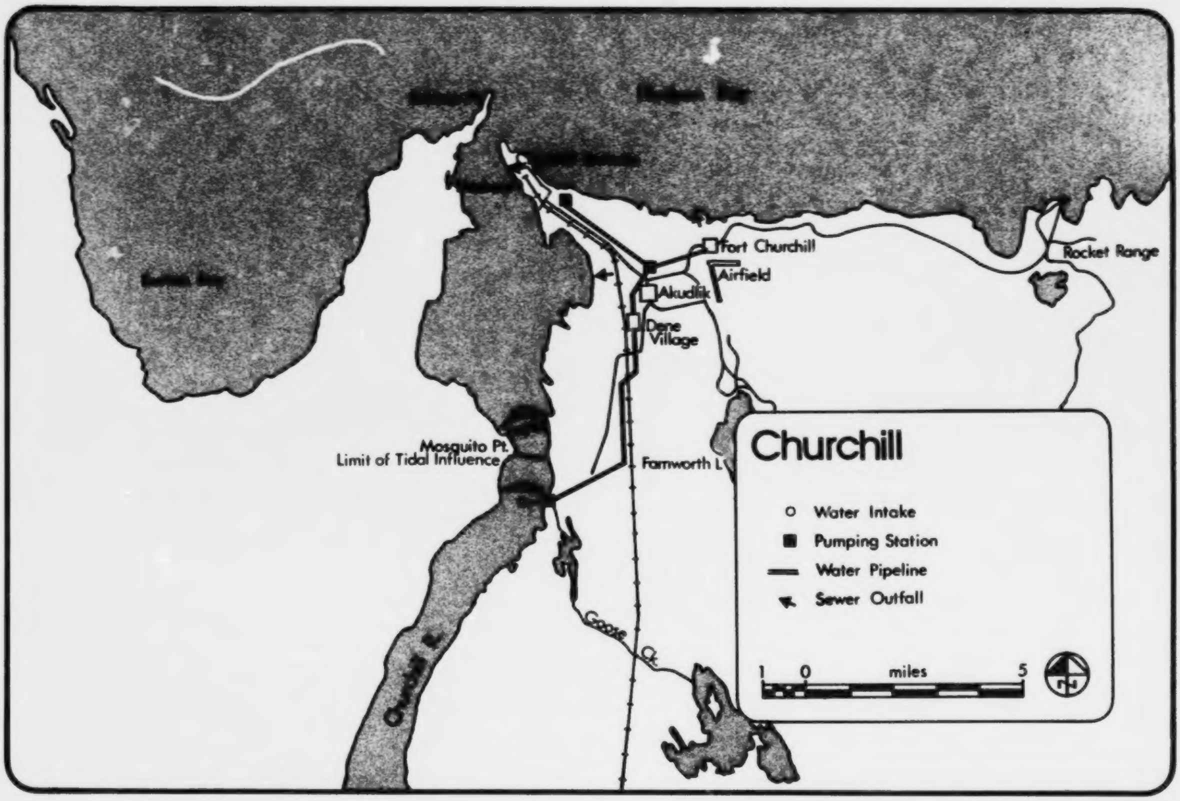

Fort Churchill
Rocket Range
Airfield
Akudlik
Dene Village
Mosquito Pt.
Limit of Tidal Influence
Farnworth L.
Goose Cr.
Churchill R.
Churchill
○ Water Intake
■ Pumping Station
— Water Pipeline
Sewer Outfall
1 0 miles 5

Fig. 9-13. Location of Water Supply and Waste Disposal Systems, Churchill.

intrude into the intake.

As explained earlier, an initial ice bridge would likely form just upstream of the intake. This could become unstable with increasing thickness or due to the shoving action of the slush and pancake ice accumulating against it. In the event of breakup of this cover, the moving ice blocks might either clog or damage the intake pipe because of the latter's proximity to the water surface.

The open water and ice cover levels with respect to the water intake level for various flows are illustrated in Fig. 9-14. It is obvious that with a discharge of 4000 cfs, and with a stable ice cover, the bottom of the ice would be at the same elevation as the intake and would impair its operation. Even a flow of 10,000 cfs may not be adequate to ensure proper functioning of the intake in midwinter.

In the salt water intrusion study, it was assumed that due to the drastic flow reduction, the salinity in the inner estuary would be considerably increased, and

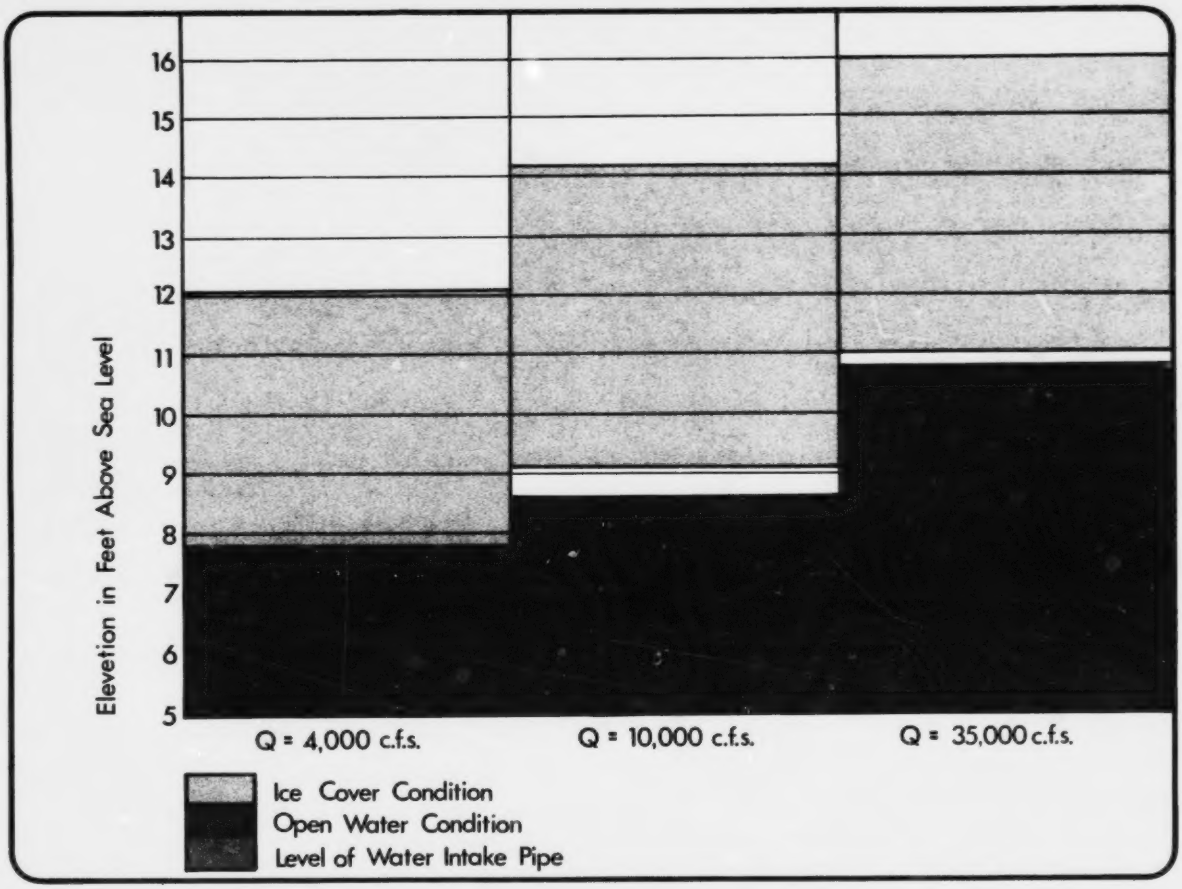


Fig. 9-14. Water and Ice levels at Water Intake Pipe, Churchill

that the stratification of salt and fresh water as well as the fresh water plug would disappear. Analysis of the interaction between tides and river flows indicated that in the case of a river flow of 4000 cfs, and a typical tide of 7.9 ft, the salt water would intrude beyond the present water intake.

The increased salinity in the estuary would also increase the external corrosion of the water main in the vicinity of the river.

Water quality would change due to a larger portion of the flow being provided by the discharges from the tributaries of the lower Churchill River. The water quality changes most likely to be noticed by the public are associated with colour and hardness. In neither case will the increase be harmful to the user, however, it may at the outset create public irritation. Water of acceptable quality, although higher in colour, will continue to be available.

WASTE DISPOSAL - The Town of Churchill is served by an extended aeration type sewage treatment plant which discharges chlorinated effluent into the Churchill River near the National Harbours Board dock. This plant went into operation in January, 1973. The plant is well operated and appears to be functioning efficiently. The discharge from the plant to the river occurs in the tidal zone.

The proposed changes in the Churchill River flow regime will have no effect on the outfall structure nor will the dilution of the discharge be affected.

## ILFORD

Ilford, with a population of approximately 200, is located on the Canadian National Railways' Hudson Bay branch line, approximately 90 miles east-northeast of Thompson. The economy centres around the railway and transportation services, fishing and, to a minor extent, trapping. Northern Indian Lake, Fidler Lake and Billard Lake have been fished in the recent past by the Ilford Co-operative Limited. From 1969 to 1973, production from these lakes accounted for about 30 percent of the Co-operatives landed value and provided an average annual total income to fishermen and packers of $15,845. Beside generating significant amounts of local income and contributing substantially to the Co-operatives production, there is also a substantial investment in lakeside stations. The replacement value of the four camps is estimated to be approximately $120,000.

If mitigation measures are not undertaken, it can be expected that the income generated by fishing these lakes will be reduced to a size where the fishery becomes uneconomic. This would result in an average loss of $1,000 to $1,150 in annual income for ten to eleven fishermen and approximately $4,500 in annual wages for packing. In addition, $120,000 in capital facilities would be abandoned. The exact effect of this closure on the Ilford Co-operative cannot be assessed. However, it appears likely that this loss would result in extreme hardship to the point where the Co-operative would be in danger of ceasing operations. This statement is reinforced by the uncertainty which surrounds the Split Lake fishery, which is part of the Ilford Co-operative's production. The Split Lake fishery is discussed in Chapter 10.

# SUGGESTED MEASURES TO MITIGATE DETRIMENTAL EFFECTS AND TO ENHANCE BENEFITS IN THE LOWER CHURCHILL RIVER AREA OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER

During the course of the investigations in the lower Churchill River area, ways were suggested to lessen the detrimental effects and to enhance the overall benefits of the Churchill River diversion project. Some of these suggestions were examined in depth and the results along with recommendations for action reported to the ministers. However, time and funding constraints prohibited investigating all suggestions in detail. These measures have been assessed according to whether they will mitigate detrimental effects or enhance benefits of the diversion project. The results are presented in Table 9-7. This table will serve as a rough guide to the examination of enhancement and mitigation measures.

## ICE REGIME

To ensure formation of the stable ice cover required to maintain downstream river flow in winter it is recommended that a minimum discharge of 4000 cfs be maintained at Missi Falls or at the outlet of Billard Lake to at least the 15th of December of each year.

It is recommended that before making the final decision to construct a proposed 1200 ft breakwater in the Churchill harbour, hydraulic model studies be undertaken to ascertain and optimize the usefulness of such a structure.

## FISHERIES

It is recommended that weirs be constructed at the outlets of the lakes in the lower Churchill River to stabilize water levels near present levels and maintain their present annual range of fluctuation. This would ensure continued spawning success for whitefish, maintain the potential fish production of the lakes near its present level, and ensure that present fish station facilities on the lakes may continue to be used.

It is recommended that a minimum average annual discharge of 5000 cfs at Missi Falls be maintained to maintain a good level of production in the lakes below.

The matter of minimum winter flows required to prevent the lower Churchill

TABLE 9-7
SUGGESTED MEASURES TO MITIGATE DETRIMENTAL EFFECTS AND TO ENHANCE BENEFITS IN THE LOWER CHURCHILL AREA
OF DIVERSION OF FLOWS FROM THE CHURCHILL RIVER

| | ● Fish Populations | ○ Efficiency of Harvesting | ● Wildlife Populations | ○ Efficiency of Harvesting | ● Outdoor Recreation Resources | ○ Utilization of Outdoor Recreation Resources | ● Transportation and Navigation services and facilities | ● Maintain Traditional Life Styles at Churchill | ● Ilford Community Income | ● Maintain Traditional Life Styles at Ilford | ● Efficiency of the Social System at Ilford |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintain a minimum discharge of 4000 cfs at Missi Falls or at the Outlet of Billard Lake up to at least December 15 each winter. | M | | M | | M | | | | | | |
| Undertake hydraulic model studies to ascertain and optimise the usefulness of the 1200 ft breakwater proposed for the Churchill harbour. | | | | | | | E | | | | |
| Construct weirs at the outlets of the lower Churchill River lakes to stabilize water levels near present levels. | M | M | M | M | M | M | | | M | M | |
| Maintain a minimum annual discharge of 5000 cfs at Missi Falls. | M | | M | | M | | | | M | M | |
| Appoint a technical committee to ascertain acceptable minimum winter flows for the lower Churchill River; meanwhile maintain a minimum winter flow of 5000 cfs. | M | | M | | M | | | | M | M | |
| Study the desirability and feasibility of increasing the range of regulation on Southern Indian Lake to improve the flow regime of the lower Churchill River. | M | M | M | M | M | M | | M | M | M | |
| Release more water earlier in spring from Missi Falls in order to maintain water levels similar to natural along the lower Churchill River throughout the waterfowl laying and incubating season. | | | M | | M | | | | | | |
| Give consideration to maintaining flows sufficient to provide the ice-scouring effect along the banks of the lower Churchill River, if in fact natural ice-scouring is eliminated. | | | M | | M | | | | | | |
| Monitor polar bear activity along Cape Churchill to determine if there is any significant delay in the bears annual departure from the mainland, and if there is a problem, maintain higher fall flows if feasible to do so. | | | | | | | | M | | | |
| Compensate trappers for any losses. | | | | | | | | | M | | |
| Establish an ongoing monitoring and management mechanism to ensure suitable use of water and related resources. | M | | M | | M | | | M | M | M | |
| Undertake a post diversion assessment of the recreational use of the lower Churchill River near the town of Churchill to determine the effect of the reduced flows and to propose mitigation measures. | | | | | M | M | | M | | | |
| Construct a weir at Mosquito Point to maintain suitable water levels for boating. | | | | | M | M | | M | | | |
| * Ensure proper functioning of the Churchill water supply by constructing weirs or storage facilities. | | | | | | | | M | | | |
| If the weirs are not built at the outlets of the lower Churchill River lakes, then provide equivalent alternatives or compensation to Ilford Co-operative fishermen for losses in income and investments. | | | | | | | | | M | M | M |
| Communicate information concerning real property losses and anticipated impacts on the resource base to the Ilford Co-operative and to individual fishermen to reduce anxiety and to enable their participation in negotiating compensation alternatives. | | | | | | | | | M | M | M |

LEGEND

M The suggested measure has the potential to cause the factor to approach the state it was prior to the diversion from the Churchill River.

E The suggested measure has the potential to increase the factor to a state greater than it was prior to the diversion from the Churchill River.

* Measures Recommended To the Ministers By the Board During The Course of The Study.

River from freezing to the bottom and to maintain acceptable levels of biological productivity in the lakes poses some difficult technical and biological problems with which there is little previous experience. It is suggested that a technical committee be appointed to decide on acceptable minimum flows in winter. The committee might include representatives of Manitoba Hydro, the Manitoba Department of Mines, Resources and Environmental Management, the Canada Department of the

Environment, and an engineering consultant. Until such a committee is formed, a minimum winter discharge of 5000 cfs is suggested as one which would with certainty maintain flow in the lower Churchill River and permit fish and wildlife populations to maintain reasonable levels.

It is recommended that appropriate government departments and agencies initiate a study to determine the desirability and feasibility of increasing the range of fluctuation on Southern Indian Lake to improve the flow regime in the lower Churchill River.

## WILDLIFE

It is recommended that consideration should be given to gradually releasing more water earlier in spring in order to maintain levels similar to natural levels along the river throughout the laying and incubating season. Under currently proposed flow patterns, destruction of waterfowl nests will occur downstream of Missi Falls with increased flows in June. Rapid increases in water level of 6 to 10 ft will occur in mid June; whereas natural increases are less than 2 to 3 ft in mid July. Under natural conditions most waterfowl eggs have hatched by the time the spring flows reach the lower Churchill River.

If elimination of natural ice-scouring does occur, it will reduce the food available to Canada geese. It is recommended that consideration be given to maintenance of flows sufficient to provide the ice-scouring effect.

With reduction in fall flows, there might be significant delay in creation of shore ice along Cape Churchill. Polar bears appear to be dependent on this ice to leave the mainland each fall. It is recommended that the situation be closely monitored and higher fall flows maintained if it is feasible to do so.

If the effects of regulation are detrimental to individual traplines, it is recommended that monetary or work compensation be considered.

The future water regime along the lower Churchill River and its resulting impact is extremely difficult to predict. Hence it is recommended that an ongoing monitoring and management mechanism be established to ensure suitable use of water and related resources.

## RECREATION

It is recommended that an assessment by the Parks Branch, Manitoba Department of Tourism, Recreation and Cultural Affairs, of the recreation use of the lower Churchill River near the town of Churchill be carried out to determine the effects of reduced flows on this use and to propose mitigation measures.

It is recommended that Manitoba Hydro examine the feasibility of constructing weirs at the outlets of Partridge Breast Lake and Northern Indian Lake to maintain lake levels and river flows at more natural levels for recreation purposes.

The Churchill River is the predominant recreation area for Churchill residents for canoeing, cottaging, fishing, hunting, etc. Reduced flows along the Churchill River will severely curtail this recreation. To mitigate this effect, it is recommended that a weir be constructed on the Churchill River at Mosquito Point to maintain higher levels. If a weir is not constructed at Mosquito Point, it is recommended that compensation be provided in some form to local residents.

## CHURCHILL WATER SUPPLY

The reduced flows along the lower Churchill River will probably cause salt water intrusion or ice damage to the Churchill water supply. It is recommended that the water supply be maintained either by the provision of additional storage capacity or by the construction of suitable weirs in the river.

## ILFORD

If the measures to maintain the fishery on the lower Churchill River lakes, which were proposed earlier in this report are not carried out, it is recommended that equivalent alternatives (relocation to a new lake) or compensation be provided to fishermen for losses in income and of investments.

Although the community social system will not be affected, certain individuals with special interests (e.g. fishing) will suffer some anxiety if not fully aware of the resource impacts. A concerted effort should be made to keep this community abreast of the anticipated impacts on the resource base of their community.

# FOOTNOTES

[9-1] J.C. Ritchie, 1962. A geobotanical survey of northern Manitoba. Arctic Inst. N. Amer. Tech. Paper No. 9. 48pp. 2 maps.

[9-2] W. F. Cowan, 1975. The impact of reduced flows on waterfowl of the lower Churchill River, preliminary assessment. Canadian Wildlife Service. 46pp.

[9-3] Province of Manitoba, Royal Commission Inquiry into Northern Transportation, 1969. Queen's Printer for the Province of Manitoba.

# chapter 10

# area 6
lower nelson river

## GEOGRAPHY

### LOCATION

The lower Nelson River has been defined for purposes of this study as that portion of the Nelson River below the Kelsey generating station including Split Lake (Fig. 10-1). The shoreline of the Kettle Rapids generating station forebay, which extends upstream to the foot of lower Gull Rapids, has already been substantially affected. It is anticipated that further changes due to the proposed increased flows in the Nelson River will be minimal in the forebay. Hence, such further changes have not been considered.

### CLIMATE

The climate of this area is humid subarctic and is characterized by cool, short summers and long, cold winters. The area lies between the 20°F and 24°F mean annual isotherms. The frost free period is 13 to 70 days and the mean annual temperatures for January and July are -15.4°F and 58.7°F respectively at Gillam. Frost has been reported every month of the year. The mean annual precipitation at Gillam is 12.6 inches.

### PHYSIOGRAPHY, TOPOGRAPHY AND SURFICIAL MATERIAL

Split Lake, which constitutes the upper portion of the lower Nelson River, is a widening of the Nelson River at its confluence with the Burntwood River. It is

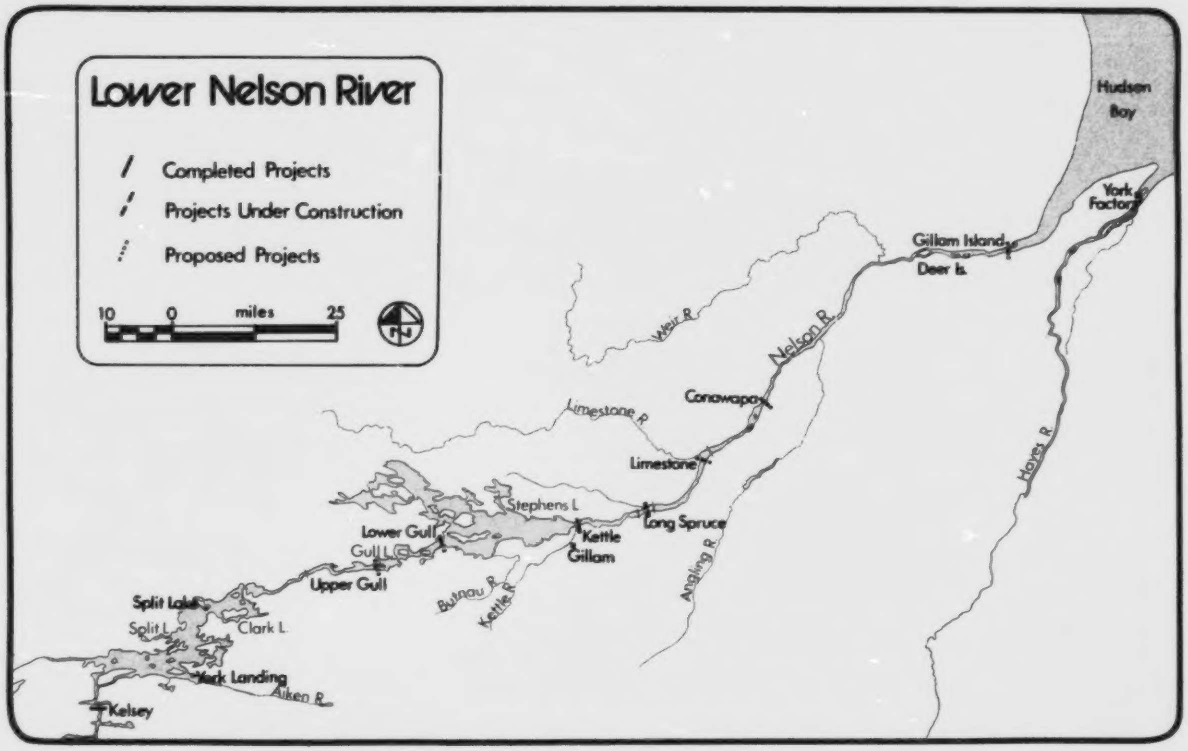

Lower Nelson River
Completed Projects
Projects Under Construction
Proposed Projects
10
0
miles
25
Hudson Bay
York Factory
Gillam Island
Deer Is.
Weir R.
Nelson R.
Conawapa
Limestone R.
Limestone
Stephens L.
Long Spruce
Kettle
Gillam
Lower Gull
Gull L.
Upper Gull
Split Lake
Split L.
Clark L.
York Landing
Aiken R.
Kelsey
Butnau R.
Kettle R.
Angling R.
Hayes R.

Fig. 10-1. Location Plan of Lower Nelson River Area.

set in a depression in rugged, bedrock-controlled topography and as a result has an irregular shoreline and very many islands, a few of them several miles long. The overburden which is thin or absent near the shoreline is predominantly lacustrine silt and clay. On flatter more poorly drained areas organic terrain is widespread.

From the outlet of Split Lake to approximately Long Spruce Rapids the overburden deepens to roughly 100 ft and more effectively masks the underlying rolling granitic bedrock topography. The overburden in this area generally consists of clayey tills with localized glaciofluvial sands and gravels, particularly near Gillam. The Nelson River has eroded through the overburden in this area and flows in an irregular channel with bedrock or bedrock-controlled shorelines. The uplands are flat to rolling.

From Long Spruce Rapids to Hudson Bay the Precambrian bedrock is overlain with limestone, dolomite and sandstone. These rock formations are overlain in turn by clayey tills and marine clays having a combined thickness of roughly 100 ft. Locally, deposits of glaciofluvial sands and gravels are found. The upland topography is flat or rolling. Marked changes in relief are observed only where the upland dips down to the Nelson River trench and along deeply incised tributaries. In this reach the Nelson River flows in a relatively straight trench roughly 100 ft deep and one-half mile wide. In the upper part of this reach the river is entrenched in the limestone bedrock which frequently rises to near channel bottom over the rest of this reach.

## VEGETATION

Black spruce forest covers most of the area. The trees become noticeably more sparse and smaller toward Hudson Bay. Extensive areas of poorly drained peat bogs and fens with scattered tamarack exist. Forest cover along the banks of lakes and rivers is more dense and varied than on the less well drained upland.

## DRAINAGE PATTERNS

The relatively flat terrain is poorly drained by numerous small streams which follow tortuous paths to the Nelson River where their valleys become deeply incised as they fall to meet the lower level of the Nelson River. The poor drainage is reflected by extensive bogs and fens. Tributary inflow into the Nelson River below Split Lake is small relative to the flow in the river (approximately 2 percent).

## HUMAN HABITATION

The community of Split Lake is located on the north shore of Split Lake approximately 80 miles northeast of Thompson. Its population is approximately 1000 of which 76 percent are Registered Indian people. As in other northern native communities, about 50 percent of the population is under the age of 15. York Landing, with a population of approximately 200, is located 10 miles south of the community of Split Lake on the south shore of the lake at the mouth of the Aikens River.

The population of Gillam, located on the Hudson Bay railway line near its crossing of the Nelson River, has increased from 356 in 1966 to 2155 in 1973 mainly as a result of the construction of the Kettle Rapids and Long Spruce generating stations by Manitoba Hydro; it will likely remain sensitive to the level of construction activity at hydroelectric generating stations on the lower Nelson River. The small native community of Fox Lake (population - 200) is associated with the town of Gillam.

A few small (one to three families) hamlets along the Hudson Bay railway line mark former water stops and maintenance crew bases.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE PHYSICAL ENVIRONMENT

## WATER REGIME CHANGES

Water regime changes considered in this study are those due to the diversion of flows from the Churchill River and regulation of flows from Lake Winnipeg. Except for the Kettle generating station, they do not include effects of generating stations now under construction or proposed for construction on the lower Nelson River.

Inasmuch as the local inflow into the lower Nelson River is only approximately 2 percent of the flow in the river, the flow throughout the lower Nelson River may be adequately represented for purposes of this study by the flow at the outlet of Split Lake as given in Table 10-1. The maximum and minimum unregulated flows listed in the table are flows which are exceeded 2 percent and 98 percent of the time respectively. Maximum and minimum regulated flows are flows which are exceeded 5 percent and 95 percent of the time respectively.

TABLE 10-1
NELSON RIVER MEAN MONTHLY FLOWS AT THE OUTLET OF SPLIT LAKE

| | Regulated | Unregulated | Change |
|---|---|---|---|
| Maximum | 216,000 cfs (June) | 173,000 cfs (July) | +43,000 cfs |
| Average | 107,000 | 80,000 | +27,000 |
| Minimum | 60,000 (May to Aug) | 25,000 (Jan,Feb,Mar) | +35,000 |
| Open-water mean | 115,000 | 97,000 | +18,000 |
| Winter median | 105,000 | 63,000 | +42,000 |

Discharges will be increased in most months, and only rarely will they be less than the unregulated flow. In the unregulated state, the highest discharges occur in midsummer (June and July), dropping from there to a low in midwinter. Regulated discharges will be highest in midsummer (except during low runoff years) dropping to a low in late summer and increasing with rising power demand to higher levels in midwinter. The average discharge will be increased by an amount equal to the mean Churchill River diversion, or by approximately 27,000 cubic feet per second (cfs).

SPLIT LAKE - Since the outlet of Split Lake is a rapids section which does not freeze over in winter, the level of Split Lake may be computed from the outflow using an open water rating curve. The levels of Split Lake computed on this basis from the flows in Table 10-1 are shown in Table 10-2.

TABLE 10-2
SPLIT LAKE MEAN MONTHLY LEVELS

| | Regulated | Unregulated | Change |
|---|---|---|---|
| Maximum | 554.4 ft<br>(June) | 551.6 ft<br>(July) | +2.8 ft |
| Average | 547.6 | 545.6 | +2.0 |
| Minimum | 544.3<br>(May to Aug) | 542.0<br>(Jan,Feb,Mar) | +2.3 |
| Long-term range | 10.1 | 9.6 | +0.5 |
| Open water mean | 547.9 | 546.7 | +1.2 |
| Winter mean | 547.2 | 544.5 | +2.7 |

NELSON RIVER, FROM SPLIT LAKE OUTLET TO LOWER GULL RAPIDS, AND FROM KETTLE RAPIDS TO HUDSON BAY - The increased flows will increase the minimum, mean and maximum, open water levels of the river on the average by 0.4, 1.1 and 2.4 ft respectively. The only significant deviation from these values occurs in that reach of the river between the Angling and Weir rivers where the water surface profile is flatter and the increases in level are twice the average values quoted.

The winter levels on the river are generally 5 to 15 ft higher and in some locations are as much as 40 ft higher than summer levels as a result of ice jams. Since the regulated mean winter discharge is roughly equal to the regulated mean summer discharge, and to the natural mean summer discharge, winter levels will almost invariably be higher than summer levels. Since the range of regulated winter flows is to a large extent within the range of natural winter flows it is anticipated that the ice jam phenomenon will not be significantly altered. The increase in ice level due to increased winter flows may be taken to be similar to the increase in the open water level for a similar increase in flow or roughly equal to 2 ft.

## Ice Regime Changes

Significant changes in the ice cover of Split Lake are not anticipated, although some deterioration of the quality of the ice cover in narrow sections may occur as a result of increased water velocities.

The normal ice cover on the channel sections of the lower Nelson River may be described as a jumbled mass of broken ice pans which have accumulated as a consequence of successive ice jams. The ice cover is at present unsuitable for transportation. This condition is not anticipated to change.

## Changes in the Chemical, Bacteriological and Physical Properties of Water

Diversion of Churchill River flows into the Nelson River system and regulation of flows from Lake Winnipeg will cause a substantial temporary lowering of the quality of water in the lower Nelson River primarily as a result of soil erosion and associated leaching of minerals along the Diversion Route, and to a lesser extent due to shoreline erosion on Split Lake and the channel sections of the Nelson River. Upon completion of the channel and shoreline adjustments a modest improvement in the quality of the water may be anticipated by virtue of a dilution effect as the higher quality Churchill River water is added to the lower quality Nelson River water.

An estimate of the probable values of these changes is presented in Table 10-3. The changes may be summarized by noting that the suspended sediment content of the water might increase initially to roughly 300 percent of its present value and then decrease to approximately 75 percent of the present value. The increase in suspended sediment is anticipated to diminish in a downstream direction and to persist for a period of about 10 years. It is anticipated that initial percentage increase in the mineral content of the Churchill River Diversion Route water and lower Nelson River water will be less than the percentage increase in suspended sediment. The significance of the increased sediment load in the Burntwood River might be placed in perspective by noting that the anticipated concentration of sediment in the Burntwood River at Split Lake (approximately 210 mg/l) is roughly one-half of the annual mean concentration in the Red River (approximately 340 mg/l) while the anticipated annual volume of sediment discharged by the Burntwood River into Split Lake (6,300,000 tons) is roughtly two and one-half times that discharged by the Red River into Lake Winnipeg (2,650,000 tons).

## PHYSICAL CHANGES TO LAKESHORES AND RIVERBANKS

SPLIT LAKE - The lake is a widening in the Nelson River at its confluence with the Burntwood. It is set in a depression in rugged, bedrock-controlled topography and as a result has an irregular shoreline and very many islands, a few of them several miles long. The shores are mostly exposed bedrock.

Along half of the 262 miles of shoreline the outcrops are narrow, only 2 to 3 ft wide and discontinuous (low bedrock-controlled shorelines). The general slope is as great as 20 ft in the first 150 ft. Bedrock is granite and gneiss; the surfaces of outcrops are irregular with many small angular boulders. Overburden is thin, and usually of lacustrine silts and clays, but is sometimes clayey till. Along these shorelines the rise of nearly 3 ft in the maximum water level will cause a very similar shoreline to reestablish itself at an elevation 3 ft higher than the existing one. Because of the small depth and erodible nature of the overburden, the adjustment should be rapid when high lake levels occur. It should, however, be noted that regulated levels will only exceed maximum unregulated levels in one year out of four on the average, and it is only during these occurrences that erosion is to be anticipated.

Some 20 percent of the shoreline consists of bedrock-controlled shoreline with an overburden beach. This typically forms a relatively regular shoreline connecting bedrock promontories. These shorelines would reestablish themselves at a higher level at a somewhat slower rate than the shoreline described earlier because of the greater volume of soil to be eroded to form the new shore profile.

Another 20 percent of the shoreline consists of steep bedrock which rises steeply out of the water at slopes of more than 20 ft in 100 ft, to as high as 50 to 60 ft above the lake. The effect of raised lake levels on such shorelines will

## TABLE 10-3
## EXISTING AND ANTICIPATED WATER QUALITY IN THE LOWER NELSON RIVER

| Constituents | Existing Lower Nelson River | Existing Churchill River | Initial Churchill River Diversion | Initial Lower Nelson River | Final Lower Nelson River |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Suspended Sediment mg/l | 21 | 4 | 210 | 69 | 16 |
| Turbidity | 14 | 4 | | | < 14 |
| Colour | 30 | 15 | | | < 30 |
| pH | 8 | 8 | | | < 8 |
| Calcium mg/l | 30 | 10 | | | 27 |
| Hardness total mg/l | 125 | 35 | | | 100 |
| Phosphorous total mg/l | .03 | .02 | | | .03 |
| Sodium mg/l | 15 | 3 | | | 12 |
| Potassium mg/l | 2 | 1 | | | 2 |

*NOTES TO TABLE 10-3*

1. *Column 2 is based on 11 samples from Split Lake and Kettle Rapids.*
2. *Column 3 is based on 11 samples from Leaf Rapids.*
3. *The suspended sediment of column 4 is based on an estimate by Underwood McLellan and Associates. (Sediment Transport Investigations for Rat - Burntwood Mitigation Study, prepared for Manitoba Hydro, August 1973). The quantity of sediment in the Burntwood River at Split Lake is estimated to be about 40 percent greater than at Thompson.*
4. *Column 5 is the sum of columns 2 and 4 weighted according to the volume of flow:* col 2 x $\frac{80,000}{107,000}$ plus col 4 x $\frac{27,000}{107,000}$
5. *Column 6 is the sum of columns 2 and 3 weighted according to the volume of flow:* col 2 x $\frac{80,000}{107,000}$ plus col 3 x $\frac{27,000}{107,000}$

be scarcely discernible.

NELSON RIVER CHANNEL - From the outlet of Split Lake to the upper end of the Kettle generating station forebay, bedrock closely controls the topography even where bedrock does not in fact form part of the land-water interface. The channel form is very irregular as are the lakeshores involved. The terrain is of moderate relief and the uplands bend down to meet the river in a smooth slope. A low ice scour zone is in evidence, never being greater than perhaps 10 ft above the water level. The increase in maximum water level under regulated conditions would cause a rapid reestablishment of a similar shoreline at an elevation some 2 ft higher than the existing one when such higher levels occur.

From Kettle Rapids to Upper Limestone Rapids the predominant shoreline may be described as a high, steep, ice-scoured till bank. The ice scour action on the lower 50 ft or so of the bank limits the vegetation to grasses and small stunted willows. Above the limit of the ice-scoured zone a closed forest of predominantly black spruce is found. Bedrock is frequently exposed at the water's edge. The remaining 20 percent of the shoreline is characterized by slumping overburden caused by toe erosion or melting permafrost. The lower half of these banks is frequently steep and bare. They are generally protected from erosion at normal water levels by a boulder or cobble layer along the shoreline, but are vulnerable to erosion at higher water levels. It is anticipated that the proposed higher water levels will have minor effects on the ice-scoured till banks - some localized erosion and bank slumping near the water's edge - but will cause a significant increase in the rate of erosion and consequent slumping of those banks that are now eroding and slumping.

From Upper Limestone Rapids to a point about 10 miles upstream of the mouth of the Angling River the Nelson River has eroded into Paleozoic bedrock so that 80 percent of the shoreline has a vertical bedrock bank up to 30 ft high which would be unaffected by the proposed increased flows. The height of the ice scour effect generally exceeds that of the bedrock cliffs and induces an ice-scoured effect on the generally steep bank above. The remaining 20 percent of the shorelines in this reach are ice-scoured till banks or shorelines with slumping overburden which would be affected by the increased levels as described earlier.

From a point approximately 10 miles upstream of Angling River to Hudson Bay, the shorelines consist of roughly equal lengths of ice-scoured till banks and shorelines with slumping overburden. The banks are similar to those described earlier except that the height of the ice-scoured zone decreases to about 5 ft as the Bay is approached. Furthermore, permafrost and the associated slumping become more widespread. Again it is anticipated that the ice-scoured till banks will be affected to a minor degree - locally increased erosion and slumping at the water's edge - but that the rate of erosion and slumping of the banks that are now eroding and slumping will be increased significantly.

# EFFECT OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE RESOURCE BASE AND ON RESOURCE UTILIZATION

## LIMNOLOGY

Studies of the limnology of the lower Nelson River were undertaken. Some temporary effect on the limnology may be anticipated as a result of the temporary change in water quality.

The silting effect could result in decreased benthos populations and therefore, reduced food supplies for fish such as whitefish, cisco, and walleye which also appear to be utilizing benthos material in Split Lake. Also, silting could have a negative effect on deposited spawn of lake spawners such as whitefish and cisco as well as any lake spawning populations of walleye and pike.

Higher turbidity will decrease primary productivity and as a result have a negative effect on all trophic levels. Moreover, greater turbidities will have an adverse effect on sight feeding young of such species as cisco, walleye, and whitefish.

## FISHERIES

In the past 5 years, commercial fishing has resulted in an average net income of about $400 per year for each of the ten to twelve residents engaged in this activity. As a result of problems arising from mercury pollution, the fishery was closed for all species except whitefish during 1970 and 1971. Fishing yields and income levels can be expected to rise with the lifting of the mercury ban. Commercial fishing on Split Lake is confined to the summer season. The commercial fishery has an average yield of 32,000 lb; primarily whitefish. In addition, there is a domestic fishery with an average yield of 25,000 lb.

The hydroelectric developments are expected to have minor effects on the fishery. Increased turbidity in Split Lake and the expected fluctuations in water levels could adversely affect fish production. Debris from the Burntwood River could result in loss of fishing nets, damage to boats and motors, and present a safety hazard.

Kettle reservoir is essentially a new "lake" and the species of fish which have become established in the past 3 years will continue to benefit from the new reservoir for a number of years. However, the exchange time in this reservoir is low and with the addition of the Churchill River diversion flows there will be even a further increase in flushing rates. With shoreline stabilization the production of this reservoir will peak and then decrease, stabilizing at a lower level relative to the present level.

## WILDLIFE HABITAT AND POPULATIONS AND WILDLIFE USE

A study of wildlife habitat and populations was not undertaken. Interpretation of the anticipated physical shoreline changes suggests that changes to wildlife habitat and consequently to wildlife would be minor and temporary.

The level of trapping activity has been very low in the recent past. Between 1967 and 1972 an average of 28 Split Lake residents did some trapping, resulting in an average annual income per trapper of approximately $525. Beaver, lynx and mink were the main species taken. Indications are that trapping activities will continue to be low in the next few years.

The impact of the hydro developments on trapping is not expected to be significant. Fur productivity will probably not be affected substantially. However there may be some short-term disruption due to shoreline access problems.

## FOREST RESOURCES AND FORESTRY

A specific study of forest resources was not undertaken. However, experience at other less remote areas in northern Manitoba with a more favourable climate suggests that the potential for a viable forestry does not exist. In any case the anticipated effects on any forest resources and possible forestry are considered to be minimal.

## MINERAL RESOURCES AND MINING

A study of mineral resources was not undertaken. The proposed increased water levels may render geological field mapping more difficult because of flooding of rock outcrops but are not anticipated to significantly affect possible mining activity.

## OUTDOOR RECREATION RESOURCES AND THEIR USE

A specific study of outdoor recreation resources and their use was not undertaken. However interpretation of anticipated shoreline changes and their duration suggests that the effects on these resources will not be substantial and will be largely dissipated by the time a demand is placed on them.

## ARCHAEOLOGICAL RESOURCES

No specific study of archaeological resources was undertaken. Should archaeological resources exist in the area some loss should be anticipated inasmuch as such resources in this area are likely to be concentrated near the shoreline and would be affected at least in part by even small increases in water level.

## TRANSPORTATION AND NAVIGATION FACILITIES AND SERVICES

At present Split Lake residents rely on water transport in the summer and an ice road across the lake in the winter. Although there is an airstrip, it is not in good condition. It is expected that the community will have an all-weather road link when the Thompson to Gillam road is constructed. York Landing, located some 10 miles south of the community of Split Lake, utilizes the same modes of transportation as the community of Split Lake. However, there are no plans to link this community to the future Thompson-Gillam road.

There is a slight possibility that timber debris could present a danger to navigation during the open water season. Also, during the winter, the increased flows through the lake could in some areas hamper road transportation by impairing the quality of the ice cover. These estimates are made on the basis of inadequate data. Nevertheless, the potential hazards to transportation appear to be significant enough to warrant close monitoring as and when actual operations are tested.

# EFFECT OF DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG ON THE COMMUNITIES

The impact of the proposed developments on the communities of Split Lake and York Landing are anticipated to be minor; a minimal effect on fishing and trapping activities which are of minor importance in the overall economies of these communities.

It is anticipated that the proposed developments will not have any detrimental effect on the community of Gillam.

# SUGGESTED MEASURES TO MITIGATE DETRIMENTAL EFFECTS AND TO ENHANCE BENEFITS IN THE LOWER NELSON RIVER AREA OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG

During the course of their investigations on the lower Nelson River area, contracting agencies suggested ways to lessen the detrimental effects and to enhance the overall benefits of the proposed developments. These measures have been assessed according to whether they will mitigate or enhance effects of the hydroelectric developments. The results are presented in Table 10-4. This will serve as a rough guide to those responsible for examining enhancement and mitigation measures.

## TABLE 10-4
## SUGGESTED MEASURES TO MITIGATE DETRIMENTAL EFFECTS AND TO ENHANCE BENEFITS IN THE LOWER NELSON RIVER AREA OF THE DIVERSION OF FLOWS FROM THE CHURCHILL RIVER AND REGULATION OF FLOWS FROM LAKE WINNIPEG

| | ● Fish Populations<br>○ Efficiency of Harvesting | ● Furbearer Populations<br>○ Efficiency of Harvesting | ● Transportation<br>○ Utilization of Transportation | ● Maintenance of Traditional Life Styles at Split Lake and York Landing | ● Efficiency of Social System at Split Lake and York Landing |
|---|---|---|---|---|---|
| Equivalent alternative (other lake or trapline). | M | M | | M | |
| Compensation for reduction in catch per unit effort. | M | M | | M | |
| Compensation for direct losses of equipment and buildings. | M | M | | M | |
| Install debris boom at mouth of Burntwood River. | M | | MM | | |
| Monitor ice conditions. | | | M | | |
| Advise affected individuals of probable effects. | | | M | M | M |
| Job training and manpower placement program. | | | | | E |

LEGEND

M The suggested measure has the potential to cause the factor to approach the state it was prior to the diversion and regulation of flows.

E The suggested measure has the potential to increase the factor to a state greater than it was prior to the diversion and regulation of flows.

lake winnipeg, churchill & nelson rivers study board CANADA MANITOBA 1971-75

# technical report
## annex a

## CANADA-MANITOBA STUDY AGREEMENT FOR
## LAKE WINNIPEG AND THE CHURCHILL AND NELSON RIVERS

THIS AGREEMENT made as of the 24th day of August, 1971.

BETWEEN THE GOVERNMENT OF CANADA,
represented herein by the
Minister of the Environment
(hereinafter called "Canada")

OF THE FIRST PART

AND THE GOVERNMENT OF THE PROVINCE
OF MANITOBA
represented herein by the
Minister of Mines, Resources
and Environmental Management
(hereinafter called "Manitoba")

OF THE SECOND PART

WHEREAS the Governments of Canada and Manitoba entered into agreements in 1963 and 1964 for joint studies of the power potential and development program for the Nelson River; and

WHEREAS the two Governments entered into a further agreement in 1966, based on the recommendation of the foregoing studies, that construction of the facilities necessary to give effect to the development of the hydro-electric potential of the Nelson River should forthwith be undertaken; and

WHEREAS the electricity generating facilities which the Province undertook to construct under the aforesaid agreement of 1966 included the generating station at the Kettle Rapids site on the Nelson River; works necessary to divert water from the Churchill River to the Nelson River; and works located in the vicinity of the outlet of Lake Winnipeg, which works will be designed to permit the levels of the water of Lake Winnipeg and the outflow to the Nelson River to be regulated and controlled; and

WHEREAS Manitoba Hydro has now installed three of the twelve units ultimately proposed for the Kettle Station and has designed the control works for the outlet of Lake Winnipeg; and

WHEREAS the Government of Manitoba has issued a license to permit Manitoba Hydro to proceed with the construction of the facilities at the outlet of Lake Winnipeg which will be completed in time to meet the electrical energy requirements foreseen for the winter of 1974/75; and

WHEREAS plans have been announced by Manitoba Hydro with the conditional approval of the Government of Manitoba to increase the energy output of generating plants on the Nelson River, commencing in the winter of 1975/76, by diverting flows from the Churchill River at Southern Indian Lake of up to a maximum of 30,000 cubic feet per second provided that the lake is not raised above the 850 foot level; and

WHEREAS the Governments of Canada and Manitoba recognize the increasing need for co-ordinating their efforts and for considering the effects on all interests in water resources planning; and

WHEREAS the social and economic welfare of the people of Manitoba depends to a large degree on the way in which the waters of Lake Winnipeg and the Churchill and Nelson Rivers are managed for energy, water supply, fisheries, wildlife, recreation and transportation; and

WHEREAS the Governments are jointly concerned that these projects achieve the greatest overall benefit possible without unduly prejudicing the present or potential development of these water bodies for other resource uses and users; and

WHEREAS His Excellency, the Governor General-in-Council by Order-in-Council P.C. 1971-1776 has authorized the Minister of the Environment to execute this Agreement on behalf of Canada; and

WHEREAS His Honour, the Lieutenant Governor-in-Council by Order-in-Council 757/71 has authorized the Minister of Mines, Resources and Environmental Management to execute this Agreement on behalf of Manitoba;

NOW THEREFORE THIS AGREEMENT WITNESSETH THAT in consideration of the premises, covenants and agreements herein contained the parties covenant and agree with each other as follows:

## 1. OBJECTIVE

The purpose of the studies authorized under this Agreement is to determine the effects that regulation of Lake Winnipeg, diversion from the Churchill River and development of hydro-electric potential of the Churchill River diversion route are likely to have on other water and related resource uses and to make recommendations for enhancing the overall benefits with due consideration for the protection of the environment.

## 2. TERMS OF REFERENCE

The study of probable effects of Manitoba Hydro's projects must be sufficiently broad so as to include all important effects on the water regime and on related resource uses and it must be adapted to provide reliable data on present natural conditions and the anticipated and actual conditions arising from the operation of the controls and diversion as designed and constructed. Recommendations will be made consistent with the stated objective of the study. Canada and Manitoba agree to give priority to those studies which may lead to recommendations for modifications or additions to the works, or operation of the works, that may be under construction, approved or proposed. Although there will be no imposed change in regime for at least the next three years, early attention will also be directed to studies which will establish and measure the parameters that define the state of nature conditions for the lakes and rivers involved. Consequently, the program will include studies of:

### (a) EFFECTS ON THE WATER REGIME

(i) Water Levels and Flows - as required to determine what changes in the existing regime can be expected to result from the operation of proposed storage and diversion works on the Churchill, Rat-Burntwood and Nelson systems, including the timing, range and frequency of fluctuations in lake levels and stream flows. Certain information will be taken as given, namely that Lake Winnipeg will be regulated between the levels of 711 and 715 feet elevation and that Southern Indian Lake will be raised to not more than 850 feet elevation for a diversion out of the Churchill River of up to 30,000 cubic feet per second. In the event that the Government of Manitoba advises that a lower level will be utilized or that an alternative or additional diversion will be used, the foregoing information will be modified accordingly.

(ii) Erosion and Sedimentation - as required to estimate changes in channel and bank morphology of both donor and receiving streams below points of diversion, and in shoreline erosion and sediment movement patterns in the larger lakes affected by regulation.

(iii) Water Quality - as required to measure existing quality and estimate changes likely to occur to water quality in storage reservoirs and in reaches downstream therefrom.

(b) EFFECTS ON THE USES OF WATER AND RELATED RESOURCES

(i) Community Supply - as required to estimate the effects of regime changes on the quantity and quality of water available for domestic, municipal and industrial use, including particularly that for the Town of Churchill; and to project any resulting benefits and any costs necessary to secure them, or for remedial measures.

(ii) Fisheries and Limnology - as required to provide an assessment of changes to be expected in the fisheries and aquatic ecosystems; to project benefits and costs for the fishery.

(iii) Wildlife - as required to assess probable changes in wildlife populations and habitats; to project benefits and costs to wildlife management and use expected from water level and flow changes.

(iv) Recreation and Tourism - as required to assess the impact of water regime changes on existing and potential tourism and recreational activities, including cottage development, sport fishing, boating and swimming; and to consider the benefits and costs of developing such additional recreation opportunities as may be facilitated by the proposed developments.

(v) Navigation - as required to assess the impact of water regime changes on existing and potential navigation; the effect of increased accessibility through Lake Kiskittogisu to Cross Lake and the effect of the reduction of fresh water ice on Churchill Harbour; and to integrate the studies herein described with those presently being carried out separately under the federal Navigable Waters Protection Act.

(vi) Forestry and Land Use - as required to inventory and evaluate the forested areas which will be flooded or made more or less accessable by proposed water development; and to examine the probable effect of depositing spoil from dredging operations on the specified muskeg or land surfaces adjacent to the excavated channels and suggest the ultimate use of land so affected, including the steps necessary, if any, for its improvement.

(vii) Mining - as required for acceleration of geologic mapping and exploration of potential mining areas along the Churchill River diversion route which are designated for flooding and to estimate the effects of changed access.

(viii) Archaeological and Historical Sites - as required to identify and determine significance of such sites in areas which are designated for flooding.

(c) SOCIAL IMPLICATIONS

(i) Project Impact - as required to assess the local impact in social and economic terms of the works, including the effects on employment, wage rates, transient population, trade, accessibility, mobility and communications; to consider and propose means of ameliorating any undesirable effects on the people of the communities in the area.

(ii) Potential Opportunities - as required to determine means by which the people of the region can, in both the short and long term, obtain the greatest advantage from the social and economic opportunities resulting from construction of the works and associated developments.

## 3. ADMINISTRATIVE ARRANGEMENT FOR JOINT PLANNING

Canada and Manitoba shall participate in a process of joint planning. To facilitate this process in the time available, the following shall be established:

A LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD to consist of six members of whom three will be appointed by Canada and three by Manitoba. The Study Board will be responsible for the study, will meet as required and will report to the Minister of the Environment of Canada and the Minister of Mines, Resources and Environmental Management of Manitoba. Chairmanship of the Study Board will rotate on an annual basis between federal and provincial members, as chosen by the members; with the first chairman being a provincial member. The Study Board will appoint a full-time Study Director and a Technical Advisory Committee of two members from each government to assist the Study Director. Under the direction of the Study Board, the Manitoba Department of Mines, Resources and Environmental Management will manage the program described herein and may employ the services of private consultants and firms as well as those of the agencies of the two governments.

## 4. FINANCING

(a) Costs of the study shall be borne as follows: Canada 50 per cent, Manitoba 50 per cent, including, but not limited to administration, the cost of collection and analysis of data, field surveys and the cost of consultants engaged as part of the program. Salaries and related costs of federal and provincial civil servants engaged in the program shall not be paid from funds approved under this Agreement excepting staff specifically assigned to or engaged in studies under this Agreement.

(b) Subject to the terms and conditions of this Agreement and subject to the funds being voted by Parliament, the aggregate sum to which Canada shall be liable in respect of this Agreement is not to exceed $1,000,000.

(c) Subject to the terms and conditions of this Agreement and subject to the funds being voted by the Legislative Assembly, the aggregate sum to which Manitoba shall be liable in respect of this Agreement is not to exceed $1,000,000.

(d) This Agreement shall become binding on the date executed. Costs incurred prior to January 1st, 1971 shall not be eligible for sharing under this Agreement. This Agreement shall terminate on December 31st, 1974, or at such earlier date as may be agreed upon by the parties hereto, but claims for costs incurred may be made up to December 31st, 1975.

(e) Each party shall keep complete records of all expenditures made severally pursuant to this Agreement and shall support such expenditures with proper documentation. Canada and Manitoba upon request shall make these records and documents available to auditors appointed by each other.

(f) Manitoba shall assume responsibility for the funding of this Agreement. The financial arrangements shall be established by the Study Board.

5. REPORTS AND RECOMMENDATIONS

(a) Specific reports or recommendations with documentation shall be submitted to the Ministers and to Manitoba Hydro at any time, as the progress of the studies reveals information or leads to proposals that may be relevant to the design or construction of works that may be proposed or in progress. The first such report to be submitted no later than December 31st, 1971 and subsequent reports not less than annually. A final report will be submitted on or before December 31st, 1974.

(b) The final report will include recommendations for such further measurements, sampling or investigations as may be desirable to provide at a later date an accurate record of the before and after effects of the works involved. An estimate of the cost of such further studies will be included.

6. GENERAL

(a) Canada and Manitoba shall exchange copies of all reports and related available information from prior and current studies for use in the program.

(b) This Agreement shall not be construed to vest in Canada any proprietary interests in projects constructed or modified hereunder.

(c) This Agreement may from time to time be reviewed by the parties hereto and, with the approval of the Governor-in-Council and the Lieutenant Governor-in-Council, may be revised.

(d) No member of the Parliament of Canada or the Legislative Assembly of Manitoba shall hold, enjoy or be admitted to any share or part of any contract, agreement, commission or benefit arising out of this Agreement.

(e) The Study Board may recommend to both parties joint participation in detailed studies over and above that which is called for in this Agreement, including the extension of the Agreement to cover studies recommended in the final report.

IN WITNESS WHEREOF the Honourable Jack Davis, Minister of the Environment has hereunto set his hand on behalf of Canada and the Honourable Sidney Green, Minister of Mines, Resources and Environmental Management, for Manitoba.

| In the Presence of | Signed on behalf of Canada | |
|---|---|---|
| "John Mullally" | "Jack Davis" | "Aug. 24, 1971"<br>Date |

| In the Presence of | Signed on behalf of Manitoba | |
|---|---|---|
| "T. E. Weber" | "Sidney Green" | "Sept. 9, 1971"<br>Date |

# SCHEDULE "A"

## AMENDMENT TO THE CANADA-MANITOBA STUDY AGREEMENT FOR LAKE WINNIPEG AND THE CHURCHILL AND NELSON RIVERS

THIS AGREEMENT made as of the day of , 1975.

BETWEEN

THE GOVERNMENT OF CANADA,
represented herein by the
Minister of the Environment
(hereinafter called "Canada")

OF THE FIRST PART

AND

THE GOVERNMENT OF THE
PROVINCE OF MANITOBA,
represented herein by the
Minister of Mines, Resources
and Environmental Management
(hereinafter called "Manitoba")

OF THE SECOND PART

WHEREAS Canada and Manitoba entered into a Study Agreement dated the 24th day of August, 1971, to determine the effects that regulation of Lake Winnipeg, diversion from the Churchill River and development of hydroelectric potential of the Churchill River diversion route are likely to have on other water and related resource uses and to make recommendations for enhancing the overall benefits with due consideration for the protection of the environment;

AND WHEREAS the Study Board established under the existing Agreement, is to submit a final report on or before December 31, 1974;

AND WHEREAS the Study Board has decided to prepare two final reports: a Summary Report and a Technical Report;

AND WHEREAS the Study Board has reassessed the time required to prepare and distribute the two reports and has recommended that the termination date for the existing Agreement be revised to April 30, 1975;

AND WHEREAS the Governor-General-in-Council by Order-in-Council P.C. 1975-3/3 of the 16th day of January, 1975, has authorized the Minister of the Environment to amend this Agreement on behalf of Canada;

AND WHEREAS the Lieutenant-Governor-in-Council by Order-in-Council No. 1592/74 of the 4th day of December, 1974, has authorized the Minister of Mines, Resources and Environmental Management of Manitoba to amend this Agreement on behalf of Manitoba.

NOW THEREFORE THIS AGREEMENT WITNESSETH that the parties hereto mutually agree as follows:

1. Section 4(d) is amended by deleting the termination date of "December 31, 1974", in the fourth line and substituting therefor the date of "April 30, 1975".
2. Section 5(a) is amended by deleting the submission date for the final report of "December 31, 1974", in the eighth line and substituting therefor the date of "April 30, 1975".

IN WITNESS WHEREOF the Honourable Jeanne Sauvé, Minister of the Environment, has hereunto set her hand on behalf of Canada and the Honourable Sidney Green, Minister of Mines, Resources and Environmental Management, has hereunto set his hand for Manitoba.

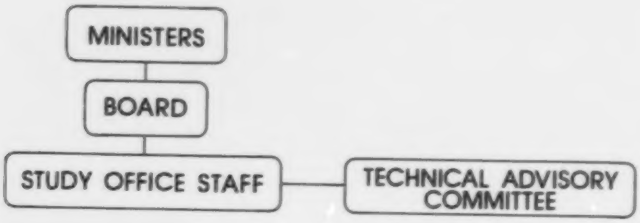
| In the presence of | Signed on behalf of Canada | |
|---|---|---|
| J. Blair Seaborn | Jeanne Sauve | March 6, 1975 |
| J. Blair Seaborn | Jeanne Sauve | Date |
| In the presence of | Signed on behalf of Manitoba | |
| Irma Kelm | | February 14/75 |
| Irma Kelm | Sidney Green | Date |

lake winnipeg, churchill & nelson rivers study board CANADA MANITOBA 1971-75

# technical report
# annex b

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY

# ORGANIZATIONAL CHART



## MINISTERS

### CANADA

The Honourable Jeanne Sauvé
1974 - 1975
- Minister of Environment Canada

The Honourable Jack Davis
1971 - 1974
- Minister of Environment Canada

### MANITOBA

The Honourable Sidney Green
1971 - 1975
- Minister of Mines, Resources and Environmental Management

## BOARD

### CANADA

N. H. James
Co-Chairman
1971 - 1975
- Director, Water Planning and Management Branch, Inland Waters Directorate, Environment Canada

E. W. Humphrys
1971 - 1975
- Senior Electrical Adviser, Energy Development Sector, Department of Energy, Mines and Resources

A. L. Hamilton
1974 - 1975
- Acting Director, Research and Development, Fisheries and Marine Service, Environment Canada

D. A. Munro
1971 - 1973
- Acting Director-General, Research and Development, Fisheries Service, Environment Canada

J. R. Vallentyne
1973 - 1974
- Senior Scientist, Fisheries and Marine Service, Environment Canada

E. M. Nicolson
Secretary
1973
- Water Planning and Management Branch, Environment Canada

### MANITOBA

N. Mudry
Co-Chairman
1971 - 1975
- Director, Planning Division, Water Resources Branch, Department of Mines, Resources and Environmental Management

C. J. Goodwin
1971 - 1975
- Corporate Planning Officer, Manitoba Hydro

J. T. Cawley
1973 - 1975
- Deputy Minister, Department of Mines, Resources and Environmental Management

K. H. Doan
1971 - 1973
- Director, Research Branch, Department of Mines, Resources and Environmental Management

G. H. MacKay
Secretary
1971 - 1972
1974 - 1975
- Assistant Director, Planning Division, Water Resources Branch, Department of Mines, Resources and Environmental Management

## TECHNICAL ADVISORY COMMITTEE

### CANADA

H. B. Rosenberg
1974 - 1975
- Chief, Socio-Economic Division, Water Planning and Management Branch, Inland Waters Directorate, Environment Canada

L. J. Johnson
1974 - 1975
- Research Scientist, Fisheries Resource Section, Fisheries and Marine Service, Environment Canada

G. S. Brown
1971 - 1974
- Head, Western Region, Engineering Division, Inland Waters Directorate, Environment Canada

J. R. Vallentyne
1971 - 1973
- Senior Scientist, Fisheries and Marine Service, Environment Canada

A. L. Hamilton
1973 - 1974
- Acting Director, Research and Development, Fisheries and Marine Service, Environment Canada

### MANITOBA

M. C. McKay
1971 - 1975
- Director, Special Programs Co-ordination and Administration Branch, Department of Northern Affairs

K. J. Ridder
1971 - 1975
- Manager of Generation Planning, Manitoba Hydro

## STUDY OFFICE STAFF

| | |
|---|---|
| Director | - D. G. Ramsey, 1974 - 1975<br>I. W. Dickson, 1971 - 1974 |
| Assistant Director | - Betty Nowicki, 1974 - 1975<br>D. J. Haggerty, 1974<br>D. G. Ramsey, 1973 - 1974<br>A. D. Bourgeois, 1972 |
| Study Planner | - Betty Nowicki, 1973 - 1974 |
| Special Adviser | - S. Trachtenberg, 1974 - 1975 |
| Administrative Officer | - R. D. Lyon, 1972 - 1975 |
| Clerk | - E. Helen Ashbey, 1972 - 1975 |
| Clerk Stenographer | - Mary H. Collins, 1974 - 1975 |
| Resource Technician | - P. E. Lorenz, 1974 - 1975 |
| Field Co-ordinator | - P. Wood, 1975<br>D. C. [illegible], 1972 - 1975 |
| Report Co-ordinator | - [illegible] I. [illegible], 1974 - 1975 |

lake winnipeg, churchill & nelson rivers study board CANADA MANITOBA 1971-75

# technical report
## annex c

## LIST OF WORKING DOCUMENTS* AND MAPS BY STUDY AREA PREPARED FOR THE LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

**Working documents which cover more than one area are listed under each area*

| TITLE | DATE SUBMITTED | REPORTING AGENCY |
|---|---|---|
| | AREA 1 LAKE WINNIPEG | |
| Lake Winnipeg South Basin Mapping Project | March, 1972 | Lockwood Survey Corporation Limited<br>Winnipeg, Manitoba |
| Lake Winnipeg Recreation Demand Study | June, 1972 | P. M. Associates Ltd.<br>Winnipeg, Manitoba |
| *Lake Winnipeg-Churchill River Diversion Transportation and Navigation Study | April, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| *Wildlife Resources Impact Assessment Lake Winnipeg, Churchill and Nelson Rivers Hydroelectric Project No. 3 - Lake Winnipeg, Lower Churchill River, and Rat-Burntwood Diversion | May, 1974 | F. F. Slaney and Company Limited<br>Vancouver, British Columbia |
| Lake Winnipeg Temporary Dykes Investigation | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *The Social and Economic Impact Study of the Churchill-Nelson Rivers Hydro Development | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Lake Winnipeg Shoreline Erosion, Sand Movement, and Ice Effects Study | August, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Water Level and Flow Information | March, 1975 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| | AREA 2 OUTLET LAKES | |
| Aspects of Channel Construction and Operations at 8-Mile and 2-Mile Channels | July, 1972 | University of Manitoba<br>Winnipeg, Manitoba |
| Outlet Lakes Transportation and Navigation Study | January, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| Forest Resource Inventory of: The Area Between the 715-Foot Elevation Contour and the West Channel and the Area to be Excavated for 2-Mile, 8-Mile, and Ominawin Bypass Channels | January, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| The Limnology-Fisheries of the Outlet Lakes Area: Present Conditions and Implications of Hydroelectric Development | March, 1973 | Environment Canada<br>Winnipeg, Manitoba |
| Wildlife Resource Impact Assessment Lake Winnipeg, Churchill and Nelson Rivers Hydroelectric Projects No. 1 - Outlet Lakes | March, 1973 | F. F. Slaney & Company Limited<br>Vancouver, British Columbia |
| An Assessment of the Archaeological Resources of the Outlet Lakes Area | March, 1973 | Churchill Diversion Archaeological Project<br>Winnipeg, Manitoba |
| *Lake Winnipeg-Churchill River Diversion Transportation and Navigation Study | April, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| Recreation Assessment of the Outlet Lakes Area | April, 1973 | Manitoba Department of Tourism, Recreation and Cultural Affairs<br>Winnipeg, Manitoba |
| *Bio-Physical Land Inventory of the Churchill-Nelson Rivers Study Area North-Central Manitoba | June, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| Water Supply and Sewage Disposal Facilities of Cross Lake and Norway House | June, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| Shoreline Geology of the West Channel of the Nelson River and Northeast Kiskitto Lake | June, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |

| TITLE | DATE SUBMITTED | REPORTING AGENCY |
|---|---|---|
| Impact Analysis of Kiskitto Lake | July, 1973 | The Lake Winnipeg, Churchill and Nelson Rivers Study Board<br>Winnipeg, Manitoba |
| *General Timber Clearing Guidelines | October, 1973 | F. F. Slaney & Company Limited<br>Vancouver, British Columbia |
| West Channel Reservoir Clearing Program | October, 1973 | F. F. Slaney & Company Limited<br>Vancouver, British Columbia |
| East Channel Hydraulic Study | November, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Timber Clearing Implications with Emphasis on the West Channel of the Nelson River, Kiskittogisu Lake and 8-Mile 2-Mile Channels | November, 1973 | Lake Winnipeg, Churchill and Nelson Rivers Study Office<br>Winnipeg, Manitoba |
| Real Property Assessment Outlet Lakes Area | November, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Review of Aspects of Channel Construction and Operation at 8-Mile Channel | January, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Anticipated Effects of Raised Lake Levels on Shorelines at Cross Lake, Manitoba | January, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| The Fisheries of the East Channel of the Nelson River | April, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *The Social and Economic Impact Study of the Churchill-Nelson Rivers Hydro Development | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Cross Lake Community Profile | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Physical Impact Study | August, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Water Level and Flow Information | March, 1975 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |

## AREA 3 DIVERSION ROUTE

| TITLE | DATE SUBMITTED | REPORTING AGENCY |
|---|---|---|
| Forest Resource Inventory of the Area from the Intersection of the Diversion Channel and Southern Indian to the Notigi Control Site up to the 850-Foot Elevation Contour | January, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Effects of Increased Flow in the Burntwood River on Shorelines near Thompson, Manitoba | March, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| *Lake Winnipeg-Churchill River Diversion Transportation and Navigation Study | April, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| An Assessment of the Archaeological Resources of the Rat-Burntwood Diversion Area | April, 1973 | Churchill Diversion Archaeological Project<br>Winnipeg, Manitoba |
| *Bio-Physical Land Inventory of the Churchill-Nelson Rivers Study Area North-Central Manitoba | June, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| *Water Supply and Sewage Disposal Facilities of Churchill and Thompson | June, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| Geology of the Ospwagan Lake (East Half) Area | July, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Rat-Burntwood Rivers System Mapping Project | July, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |

| TITLE | DATE SUBMITTED | REPORTING AGENCY |
|---|---|---|
| Anticipated Effects of Raised Lake Levels on Shorelines at Nelson House, Manitoba | August, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| *Southern Indian Lake - Rat-Burntwood Diversion, Transportation and Navigation Study, Part One | October, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| *General Timber Clearing Guidelines | October, 1973 | F. F. Slaney & Company Limited<br>Vancouver, British Columbia |
| *Real Property Assessment Southern Indian Lake and Rat-Burntwood Diversion Route | November, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Proposed Development Set-Back Line for Nelson House, Manitoba | February, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Aspects of Channel Construction and Operation for the South Bay-Issett Lake Diversion Channel | March, 1974 | University of Manitoba<br>Winnipeg, Manitoba |
| *The Fisheries of the Lower Churchill River and Diversion Route Lakes: Exploitation and Reproduction | March, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Southern Indian Lake - Rat-Burntwood Diversion, Transportation and Navigation Study, Part Two | April, 1974 | University of Manitoba<br>Winnipeg, Manitoba |
| Recreation Assessment of the Rat-Burntwood Diversion Route | April, 1974 | Manitoba Department of Tourism, Recreation and Cultural Affairs<br>Winnipeg, Manitoba |
| *Recommendations of Study Participants for Pre-Flood Clearing on Southern Indian Lake and the Diversion Route | April, 1974 | Lake Winnipeg, Churchill and Nelson Rivers Study Office<br>Winnipeg, Manitoba |
| *Additional Recommendations of Study Participants for Pre-Flood Clearings on Southern Indian Lake and the Diversion Route | April, 1974 | Lake Winnipeg, Churchill and Nelson Rivers Study Office<br>Winnipeg, Manitoba |
| *Wildlife Resource Impact Assessment Lake Winnipeg, Churchill and Nelson Rivers Hydroelectric Projects No. 3 - Lake Winnipeg, Lower Churchill River, Rat-Burntwood Diversion | May, 1974 | F. F. Slaney & Company Limited<br>Vancouver, British Columbia |
| Nelson House Community Profile | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *The Social and Economic Impact Study of the Churchill-Nelson Rivers Hydro Development | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Forest Resource Inventory of the Area Between the Notigi Control Site and the Manasan Generating Site Anticipated to be Flooded as a Result of the Churchill River Diversion Project | July, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *The Morphometry of Rat-Burntwood Diversion Route and Lower Churchill River Lakes: Present Conditions and Post Regulation Conditions | July, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Summary of Fisheries - Limnology Investigations on the Lower Churchill Lakes and on the Rat-Burntwood Lakes | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Hydrographic Survey of Lakes on the Lower Churchill and Rat-Burntwood Rivers and Reservoirs and Lakes on the Nelson River | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Phytoplankton and Primary Productivity of the Lower Churchill Lakes, the Rat-Burntwood Lakes and the Nelson River Lakes and Reservoirs | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Crustacean Plankton of Lakes on the Lower Churchill River and Rat-Burntwood Rivers Systems | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Zoobenthos Survey of the Lower Churchill River and Diversion Route Lakes | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |

| TITLE | DATE SUBMITTED | REPORTING AGENCY |
|---|---|---|
| *The Fisheries of the Lower Churchill Lakes, the Rat-Burntwood Lakes and the Upper Nelson Lakes: Present Conditions and the Implications of Hydroelectric Development | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Physical Impact Study | August, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Water Level and Flow Information | March, 1975 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Water Supply and Sewage Disposal Facilities of Leaf Rapids, South Indian Lake and Nelson House | March, 1975 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |

## AREA 4 SOUTHERN INDIAN LAKE

| | | |
|---|---|---|
| Forest Resource Inventory of the Area Between the 850-Foot Elevation Contour and Southern Indian Lake | January, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Lake Winnipeg - Churchill River Diversion Transportation and Navigation Study | April, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| *Bio-Physical Land Inventory of the Churchill Rivers Study Area North-Central Manitoba | June, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| Social and Economic Impact of the Nelson River Hydro Development (With Emphasis on South Indian Lake) | June, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Southern Indian Lake - Rat-Burntwood Diversion, Transportation and Navigation Study, Part One | October, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| The Fisheries of Southern Indian Lake | October, 1973 | Environment Canada<br>Winnipeg, Manitoba |
| *General Timber Clearing Guidelines | October, 1973 | F. F. Slaney & Company Limited<br>Vancouver, British Columbia |
| *Real Property Assessment Southern Indian Lake and Rat-Burntwood Diversion Route | November, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Recreation Assessment, Southern Indian Lake | November, 1973 | Manitoba Department of Tourism, Recreation and Cultural Affairs<br>Winnipeg, Manitoba |
| Anticipated Effects of Raised Lake Levels on Shorelines at South Indian Lake, Manitoba | December, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| Wildlife Resource Impact Assessment, Lake Winnipeg, Churchill and Nelson Rivers Hydroelectric Projects No. 2 - Southern Indian Lake | February, 1974 | F. F. Slaney & Company Limited<br>Vancouver, British Columbia |
| Anticipated Effects of the Churchill River Diversion Project on the Ice Cover of Southern Indian Lake | February, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Summary of Fisheries - Limnology Investigations on Southern Indian Lake | February, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| The Morphometry of Southern Indian Lake: Present Conditions and Implications of Hydroelectric Development | February, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| Southern Indian Lake: Sedimentary Environments, Recent Basin History and Implications of Inundation and Diversion | February, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| Phytoplankton and Primary Production in Southern Indian Lake | February, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| Zooplankton Study in Southern Indian Lake | February, 1974 | Environment Canada<br>Winnipeg, Manitoba |

| TITLE | DATE SUBMITTED | REPORTING AGENCY |
|---|---|---|
| Zoobenthos Survey of Southern Indian Lake | February, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| The Fisheries of Southern Indian Lake, Present Conditions and Implications of Hydroelectric Development | February, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| Simulation of Alternatives for the South Indian Lake Commercial Fishery | March, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Southern Indian Lake - Rat-Burntwood Diversion, Transportation and Navigation Study, Part Two | April, 1974 | University of Manitoba<br>Winnipeg, Manitoba |
| *Recommendations of Study Participants for Pre-Flood Clearing on Southern Indian Lake and the Diversion Route | April, 1974 | Lake Winnipeg, Churchill and Nelson Rivers Study Office<br>Winnipeg, Manitoba |
| *Additional Recommendations of Study Participants for Pre-Flood Clearing on Southern Indian Lake and the Diversion Route | April, 1974 | Lake Winnipeg, Churchill and Nelson Rivers Study Office<br>Winnipeg, Manitoba |
| *The Social and Economic Impact Study of the Churchill-Nelson Rivers Hydro Development | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| The Hydrography of Southern Indian Lake: Present Conditions and Implications of Hydroelectric Development | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Physical Impact Study | August, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Water Level and Flow Information | March, 1975 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Water Supply and Sewage Disposal Facilities of Leaf Rapids, South Indian Lake and Nelson House | March, 1975 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |

## AREA 5 LOWER CHURCHILL RIVER

| | | |
|---|---|---|
| *Lake Winnipeg - Churchill River Diversion Transportation and Navigation Study | April, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| *Water Supply and Sewage Disposal Facilities of Churchill and Thompson | June, 1973 | University of Manitoba<br>Winnipeg, Manitoba |
| *The Fisheries of the Lower Churchill River and Diversion Route Lakes: Exploitation and Reproduction | March, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| Recreation Assessment of the Lower Churchill River | April, 1974 | Manitoba Department of Tourism, Recreation and Cultural Affairs<br>Winnipeg, Manitoba |
| *Wildlife Resource Impact Assessment, Lake Winnipeg, Churchill and Nelson Rivers Hydroelectric Projects, No. 3 - Lake Winnipeg, Lower Churchill River, Rat-Burntwood Diversion | May, 1974 | F. F. Slaney & Company Limited<br>Vancouver, British Columbia |
| Post-Diversion Ice Regime Study of the Lower Churchill River | May, 1974 | LaSalle Hydraulic Laboratory Ltd.<br>LaSalle, Quebec |
| *The Social and Economic Impact Study of the Churchill-Nelson Rivers Hydro Development | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *The Morphometry of Rat-Burntwood Diversion Route and Lower Churchill River Lakes: Present Conditions and Post Regulation Conditions | July, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Summary of Fisheries - Limnology Investigations of the Lower Churchill Lakes and on the Rat-Burntwood Lakes | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |

| TITLE | DATE SUBMITTED | REPORTING AGENCY |
|---|---|---|
| *Hydrographic Survey of Lakes on the Lower Churchill and Rat-Burntwood Rivers and Reservoirs and Lakes on the Nelson River | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Phytoplankton and Primary Productivity of the Lower Churchill Lakes, the Rat-Burntwood Lakes, and the Nelson River Lakes and Reservoirs | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Crustacean Plankton of Lakes on the Lower Churchill River and Rat-Burntwood River Systems | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Zoobenthos Survey of the Lower Churchill River and Diversion Route Lakes | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *The Fisheries of the Lower Churchill Lakes, the Rat-Burntwood Lakes and the Upper Nelson Lakes: Present Conditions and Implications of Hydroelectric Development | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Physical Impact Study | August, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Water Level and Flow Information | March, 1975 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| **AREA 6 LOWER NELSON RIVER** | | |
| *The Social and Economic Impact Study of the Churchill-Nelson Rivers Hydro Development | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Hydrographic Survey of Lakes on the Lower Churchill and Rat-Burntwood Rivers, and Reservoirs and Lakes on the Nelson River | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Physical Impact Study | August, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| *Phytoplankton and Primary Production of the Lower Churchill Lakes, the Rat-Burntwood Lakes and the Nelson River Lakes and Reservoirs | August, 1974 | Environment Canada<br>Winnipeg, Manitoba |
| *Water Level and Flow Information | March, 1975 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| **GENERAL** | | |
| Progress Report Number 1 | December, 1971 | Lake Winnipeg, Churchill and Nelson Rivers Study Board<br>Winnipeg, Manitoba |
| Report on Indian Affairs Branch Human Resource Survey | November, 1972 | Acres Consulting Services Ltd.<br>Winnipeg, Manitoba |
| Report on Socio-Economic Data Sources for Selected Northern Manitoba Communities | November, 1972 | Acres Consulting Services Ltd.<br>Winnipeg, Manitoba |
| Progress Report Number 2 | December, 1972 | Lake Winnipeg, Churchill and Nelson Rivers Study Board<br>Winnipeg, Manitoba |
| Social Impact Program | January, 1973 | Nesbitt Educational Enterprises Ltd.<br>Winnipeg, Manitoba |
| Literature Review: Socio-Economic Impact Pertaining to Native People | February, 1973 | Acres Consulting Services Ltd.<br>Winnipeg, Manitoba |
| Effects of Increasing Lake Levels on Forests Adjacent to New Shorelines | March, 1973 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |

| TITLE | DATE SUBMITTED | REPORTING AGENCY |
|---|---|---|
| Progress Report Number 3 | December, 1973 | Lake Winnipeg, Churchill and Nelson Rivers Study Board<br>Winnipeg, Manitoba |
| Social Change and Stress: A Focus on Northern Development | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| A Northern Manitoba Native Cultural Centre or Museum: A Proposal | June, 1974 | Manitoba Department of Mines, Resource Environmental Management<br>Winnipeg, Manitoba |
| The Impact of Development on Nutrition in Remote Northern Manitoba Communities | June, 1974 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |
| Results of Water Sampling Program in Northern Manitoba | February, 1975 | Manitoba Department of Mines, Resources and Environmental Management<br>Winnipeg, Manitoba |

lake winnipeg, churchill & nelson rivers study board CANADA MANITOBA 1971-75

# technical report
# annex d

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

# LIST OF APPENDICES

| | | |
|---|---|---|
| Appendix 1 | Background Documents and Interim Reports | |
| Appendix 2 | Hydrologic, Hydraulic and Geomorphologic Studies | Vol. 1<br>Vol. 2 |
| Appendix 3 | Biophysical, Forestry and Geological Studies | |
| Appendix 4 | Existing Works and Services | |
| Appendix 5 | Fisheries and Limnology Studies | Vol. 1<br>Vol. 2 |
| Appendix 6 | Wildlife Studies | |
| Appendix 7 | Recreation and Archaeological Studies | |
| Appendix 8 | Social and Economic Studies | Vol. 1<br>Vol. 2<br>Vol. 3 |

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

## APPENDIX 1 - BACKGROUND DOCUMENTS AND INTERIM REPORTS

A - CANADA-MANITOBA STUDY AGREEMENT FOR LAKE WINNIPEG AND THE CHURCHILL AND NELSON RIVERS

B - AMENDMENT TO THE CANADA-MANITOBA STUDY AGREEMENT FOR LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY

C - INTERIM LICENSE FOR THE REGULATION OF WATER LEVELS FOR WATER POWER PURPOSES - LAKES WINNIPEG, PLAYGREEN AND KISKITTOGISU

D - SUPPLEMENTARY INTERIM LICENSE FOR THE REGULATION OF WATER LEVELS FOR WATER POWER PURPOSES - LAKES WINNIPEG, PLAYGREEN AND KISKITTOGISU

E - INTERIM LICENSE FOR THE DEVELOPMENT OF WATER POWER - JENPEG SITE, WEST CHANNEL OF NELSON RIVER

F - INTERIM LICENSE FOR THE DIVERSION OF WATER FROM THE CHURCHILL RIVER TO THE NELSON RIVER, AND THE IMPOUNDMENT OF WATER ON THE RAT RIVER AND SOUTHERN INDIAN LAKE

G - LICENSE TO IMPOUND WATER ON SOUTHERN INDIAN LAKE AND RAT RIVER, DIVERT WATER FROM CHURCHILL RIVER TO NELSON RIVER, AND USE WATER FOR POWER PRODUCTION PURPOSES

H - APPROVAL OF THE CHURCHILL RIVER DIVERSION WORKS AND SITE-LOCATIONS

I - INTERIM LICENSE FOR THE DEVELOPMENT OF WATER POWER - MISSI FALLS SITE, CHURCHILL RIVER

J - PROGRESS REPORT NUMBER 1, DECEMBER 31, 1971

K - PROGRESS REPORT NUMBER 2, DECEMBER 31, 1972

L - PROGRESS REPORT NUMBER 3, DECEMBER 31, 1973

M - IMPACT ANALYSIS OF KISKITTO LAKE REGULATION

N - GENERAL TIMBER CLEARING GUIDELINES

O - TIMBER CLEARING IMPLICATIONS WITH EMPHASIS ON THE WEST CHANN OF THE NELSON RIVER, KISKITTOGISU LAKE, AND 8-MILE AND 2-MILE CHANNELS

P - LONG TERM ECOLOGICAL MONITORING OF THE LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS IMPACT AREAS

Q - RECOMMENDATIONS OF STUDY PARTICIPANTS FOR PRE-FLOOD CLEARIN ON SOUTHERN INDIAN LAKE AND THE DIVERSION ROUTE

R - ADDITIONAL RECOMMENDATIONS OF STUDY PARTICIPANTS FOR PRE-FLOOD CLEARING ON SOUTHERN INDIAN LAKE AND THE DIVERSION ROUTE

S - ASSESSMENT OF THE IMPACT OF THE CHURCHILL RIVER DIVERSION ON THE CHURCHILL RIVER ESTUARY AREA

T - POSSIBILITY OF A ONE YEAR DELAY IN RAISING THE LEVEL OF SOUTHERN INDIAN LAKE

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

## APPENDIX 2 - HYDROLOGIC, HYDRAULIC AND GEOMORPHOLOGIC STUDIES, VOL. 1

A - PHYSICAL IMPACT STUDY

B - LAKE WINNIPEG SHORELINE EROSION, SAND MOVEMENT AND ICE EFFECTS STUDY

C - ASPECTS OF CHANNEL CONSTRUCTION AND OPERATION AT 8-MILE AND 2-MILE CHANNELS

D - REVIEW OF ASPECTS OF CHANNEL CONSTRUCTION AND OPERATION AT 8-MILE CHANNEL

E - ASPECTS OF CHANNEL CONSTRUCTION AND OPERATION FOR THE SOUTH BAY - ISSETT LAKE DIVERSION CHANNEL

F - ANTICIPATED EFFECTS OF THE CHURCHILL RIVER DIVERSION PROJECT ON THE ICE COVER OF SOUTHERN INDIAN LAKE

G - POST-DIVERSION ICE REGIME STUDY OF THE LOWER CHURCHILL RIVER

H - EAST CHANNEL HYDRAULIC STUDY

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

# APPENDIX 2 - HYDROLOGIC, HYDRAULIC AND GEOMORPHOLOGIC STUDIES, VOL. 2

A - RESULTS OF WATER SAMPLING PROGRAM IN NORTHERN MANITOBA 1972-1974

B - WATER LEVEL AND FLOW INFORMATION

C - LAKE WINNIPEG SOUTH BASIN MAPPING PROJECT

D - RAT-BURNTWOOD RIVERS SYSTEM MAPPING PROJECT

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

## APPENDIX 3 - BIOPHYSICAL, FORESTRY AND GEOLOGICAL STUDIES

A - BIO-PHYSICAL LAND INVENTORY OF THE CHURCHILL-NELSON RIVERS STUDY AREA: NORTH-CENTRAL MANITOBA

B - FOREST RESOURCE INVENTORY OF: THE AREA BETWEEN THE 715-FOOT ELEVATION CONTOUR AND THE WEST CHANNEL AND THE AREA TO BE EXCAVATED FOR 2-MILE, 8-MILE AND OMINAWIN BYPASS CHANNELS

C - FOREST RESOURCE INVENTORY OF THE AREA FROM THE INTERSECTION OF THE DIVERSION CHANNEL AND SOUTHERN INDIAN LAKE TO THE NOTIGI CONTROL SITE UP TO THE 850-FOOT ELEVATION CONTOUR

D - FOREST RESOURCE INVENTORY OF THE AREA BETWEEN THE NOTIGI CONTROL SITE AND THE MANASAN GENERATING SITE ANTICIPATED TO BE FLOODED AS A RESULT OF THE CHURCHILL RIVER DIVERSION PROJECT

E - FOREST RESOURCE INVENTORY OF THE AREA BETWEEN THE 850-FOOT ELEVATION CONTOUR AND SOUTHERN INDIAN LAKE

F - THE EFFECTS OF INCREASING LAKE LEVELS ON FORESTS ADJACENT TO NEW SHORELINES

G - WEST CHANNEL RESERVOIR CLEARING PROGRAM

H - SHORELINE GEOLOGY OF THE WEST CHANNEL OF THE NELSON RIVER AND NORTHEAST KISKITTO LAKE

I - GEOLOGY OF THE OSPWAGAN LAKE (EAST HALF) AREA

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

## APPENDIX 4 - EXISTING WORKS AND SERVICES

A - LAKE WINNIPEG TEMPORARY DYKES INVESTIGATION

B - REAL PROPERTY ASSESSMENT - OUTLET LAKES AREA

C - ANTICIPATED EFFECTS OF RAISED LAKE LEVELS ON SHORELINES AT CROSS LAKE, MANITOBA

D - REAL PROPERTY ASSESSMENT - SOUTHERN INDIAN LAKE AND THE RAT-BURNTWOOD DIVERSION ROUTE

E - EFFECTS OF INCREASED FLOW IN THE BURNTWOOD RIVER ON SHORELINES NEAR THOMPSON, MANITOBA

F - ANTICIPATED EFFECTS OF RAISED LAKE LEVELS ON SHORELINES AT NELSON HOUSE, MANITOBA

G - PROPOSED DEVELOPMENT SET-BACK LINE FOR NELSON HOUSE, MANITOBA

H - ANTICIPATED EFFECTS OF RAISED LAKE LEVELS ON SHORELINES AT SOUTH INDIAN LAKE, MANITOBA

I - WATER SUPPLY AND SEWAGE DISPOSAL FACILITIES OF CROSS LAKE AND NORWAY HOUSE

J - WATER SUPPLY AND SEWAGE DISPOSAL FACILITIES OF LEAF RAPIDS, SOUTH INDIAN LAKE AND NELSON HOUSE

K - WATER SUPPLY AND SEWAGE DISPOSAL FACILITIES OF CHURCHILL AND THOMPSON

L - LAKE WINNIPEG REGULATION - CHURCHILL RIVER DIVERSION - TRANSPORTATION AND NAVIGATION STUDY

M - OUTLET LAKES TRANSPORTATION AND NAVIGATION STUDY

N - SOUTHERN INDIAN LAKE - RAT-BURNTWOOD DIVERSION - TRANSPORTATION AND NAVIGATION STUDY (PART ONE)

O - SOUTHERN INDIAN LAKE - RAT-BURNTWOOD RIVER DIVERSION - TRANSPORTATION AND NAVIGATION STUDY (PART TWO)

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

## APPENDIX 5 - FISHERIES AND LIMNOLOGY STUDIES, VOL. 1

A - SUMMARY OF FISHERIES-LIMNOLOGY INVESTIGATIONS ON SOUTHERN INDIAN LAKE

B - THE MORPHOMETRY OF SOUTHERN INDIAN LAKE: PRESENT CONDITIONS AND IMPLICATIONS OF HYDROELECTRIC DEVELOPMENT

C - THE HYDROGRAPHY OF SOUTHERN INDIAN LAKE: PRESENT CONDITIONS AND IMPLICATIONS OF HYDROELECTRIC DEVELOPMENT

D - SOUTHERN INDIAN LAKE: SEDIMENTARY ENVIRONMENTS, RECENT BASIN HISTORY AND IMPLICATIONS OF INUNDATION AND DIVERSION

E - PHYTOPLANKTON AND PRIMARY PRODUCTION IN SOUTHERN INDIAN LAKE

F - ZOOPLANKTON STUDY IN SOUTHERN INDIAN LAKE

G - ZOOBENTHOS SURVEY OF SOUTHERN INDIAN LAKE

H - THE FISHERIES OF SOUTHERN INDIAN LAKE: PRESENT CONDITIONS AND IMPLICATIONS OF HYDROELECTRIC DEVELOPMENT

J - THE FISHERIES OF SOUTHERN INDIAN LAKE: EXPLOITATION AND REPRODUCTION

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

# APPENDIX 5 - FISHERIES AND LIMNOLOGY STUDIES, VOL. 2

A - THE LIMNOLOGY-FISHERIES OF THE OUTLET LAKES AREA: PRESENT CONDITIONS AND IMPLICATIONS OF HYDROELECTRIC DEVELOPMENT

B - THE FISHERIES OF THE EAST CHANNEL OF THE NELSON RIVER

C - SUMMARY OF FISHERIES-LIMNOLOGY INVESTIGATIONS ON THE LOWER CHURCHILL LAKES AND ON THE RAT-BURNTWOOD LAKES

D - THE MORPHOMETRY OF RAT-BURNTWOOD DIVERSION ROUTE AND LOWER CHURCHILL RIVER LAKES: PRESENT CONDITIONS AND POST REGULATION CONDITIONS

E - HYDROGRAPHIC SURVEY OF LAKES ON THE LOWER CHURCHILL AND RAT-BURNTWOOD RIVERS AND RESERVOIRS AND LAKES OF THE NELSON RIVER

F - PHYTOPLANKTON AND PRIMARY PRODUCTIVITY OF THE LOWER CHURCHILL LAKES, THE RAT-BURNTWOOD LAKES, AND THE NELSON RIVER LAKES AND RESERVOIRS

G - CRUSTACEAN PLANKTON OF LAKES ON THE LOWER CHURCHILL RIVER AND RAT-BURNTWOOD RIVER SYSTEMS

H - ZOOBENTHOS SURVEY OF THE LOWER CHURCHILL RIVER AND DIVERSION ROUTE LAKES

I - THE FISHERIES OF THE LOWER CHURCHILL LAKES, THE RAT-BURNTWOOD LAKES AND THE UPPER NELSON LAKES: PRESENT CONDITIONS AND THE IMPLICATIONS OF HYDROELECTRIC DEVELOPMENT

J - THE FISHERIES OF THE LOWER CHURCHILL RIVER AND DIVERSION ROUTE LAKES: EXPLOITATION AND REPRODUCTION

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

# APPENDIX 6 - WILDLIFE STUDIES

A - WILDLIFE RESOURCE IMPACT ASSESSMENT - LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS HYDROELECTRIC PROJECTS - No. 1 - OUTLET LAKES

B - WILDLIFE RESOURCE IMPACT ASSESSMENT - LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS HYDROELECTRIC PROJECTS - No. 2 - SOUTHERN INDIAN LAKE

C - WILDLIFE RESOURCE IMPACT ASSESSMENT - LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS HYDROELECTRIC PROJECTS - No. 3 - LAKE WINNIPEG, LOWER CHURCHILL RIVER, RAT-BURNTWOOD DIVERSION

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

## APPENDIX 7 - RECREATION AND ARCHAEOLOGICAL STUDIES

A - LAKE WINNIPEG RECREATION DEMAND STUDY

B - RECREATION ASSESSMENT OF THE OUTLET LAKES AREA

C - RECREATION ASSESSMENT OF THE RAT-BURNTWOOD DIVERSION ROUTE

D - RECREATION ASSESSMENT - SOUTHERN INDIAN LAKE

E - RECREATION ASSESSMENT OF THE LOWER CHURCHILL RIVER

F - AN ASSESSMENT OF THE ARCHAEOLOGICAL RESOURCES OF THE OUTLET LAKES AREA

G - AN ASSESSMENT OF THE ARCHAEOLOGICAL RESOURCES OF THE RAT-BURNTWOOD DIVERSION AREA

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

# APPENDIX 8 - SOCIAL AND ECONOMIC STUDIES, VOL. 1

## A - SOCIAL AND ECONOMIC IMPACT STUDY OF THE LAKE WINNIPEG, CHURCHILL-NELSON RIVERS HYDRO DEVELOPMENT

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

# APPENDIX 8 - SOCIAL AND ECONOMIC STUDIES, VOL. 2

A - CROSS LAKE COMMUNITY PROFILE

B - NELSON HOUSE COMMUNITY PROFILE

C - SOCIAL AND ECONOMIC IMPACT OF THE NELSON RIVER HYDRO DEVELOPMENT (WITH EMPHASIS ON SOUTH INDIAN LAKE)

LAKE WINNIPEG, CHURCHILL AND NELSON RIVERS STUDY BOARD

## APPENDIX 8 - SOCIAL AND ECONOMIC STUDIES, VOL. 3

A - SOCIAL CHANGE AND STRESS: A FOCUS ON NORTHERN DEVELOPMENT

B - A PROPOSAL FOR A NORTHERN MANITOBA NATIVE CULTURAL CENTRE OR MUSEUM

C - THE IMPACT OF DEVELOPMENT ON NUTRITION IN REMOTE NORTHERN MANITOBA COMMUNITIES

D - SIMULATION OF ALTERNATIVES FOR THE SOUTH INDIAN LAKE COMMERCIAL FISHERY

E - REPORT ON INDIAN AFFAIRS BRANCH HUMAN RESOURCE SURVEY

F - REPORT ON SOCIO-ECONOMIC DATA SOURCES FOR SELECTED NORTHERN MANITOBA COMMUNITIES

G - SOCIAL IMPACT PROGRAM

H - LITERATURE REVIEW: SOCIO-ECONOMIC IMPACT PERTAINING TO NATIVE PEOPLE